

A report on

The principles, practice and current challenges of Industry 4.0 technologies

University of Wales Trinity Saint David
(MADE Project)



By
Darren Bright (2134166)
25/07/2022

Wales Institute of Science and Art
Mahesh Kannath

The main purpose of this report is to understand principles, practice and current challenges of Industry 4.0 technologies I am currently working with but primarily focussing one technology. I looked at journal entries and web based articles along with personal experiences based around the use of Augmented real-time smart glasses (ARSG).

The data I collected from the various sources but primarily the IEEE Access (ANNA SYBERFELDT, 2017," Augmented reality. Augmented Reality Smart Glasses"p.13) journal I found was very informative and aligned with my experiences. Within the main body of my report I have used a format of What, Where and how which is a usual format I use in work reports. In addition to this, there is the technical report, costs and time line again something I would use in work documents.

Ultimately, to wrap up my report I've highlighted that the Industry 4.0 technology of ARSG's has been successfully implemented and used on site successfully and in times of pressure being the COVID pandemic.

Introduction

Industry 4.0 was a word used within our organisation for many years but rarely did it mean anything. As a Global company Berry were thinking about how to reform themselves in the European plants. Back in the summer of 2019, the first internal Industry 4.0 meetings were taking place with the aim of setting up Officers and multiplications that could lead the 4.0 journey. Directors and Managers were introduced to the theory behind industry 4.0 and that industry 4.0 is often used as buzzword indication moving on from the 3rd industry revolution by moving towards digitalisation. As Berry global has multiple factories, it was quickly realised that there were vast differences between sites ranging from some factories within the organisation still using similar technologies to the first programmable logic controllers (PLC's) that were seen at the beginning of the 3rd industrial revolution. The other end of the spectrums seen Factories using systems close to Industry 4.0 technologies such as SCADA, Robotics and digital cloud based platforms. The Multiplications set about looking at the principles of industry 4.0 and what practices we would take forward.

My report will be written based on our Industry 4.0 Journey at Berry Aberdare that really accelerated due to the impact that COVID 19 had on a part of our business and highlighted why we had to move on with Industry 4.0 on our manufacturing site.

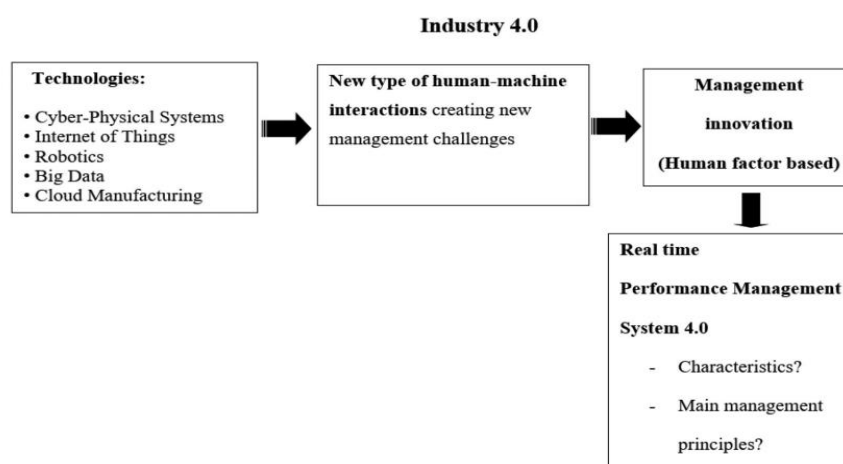
Within the report, i will look at principles, practices and future methods we are working with or have started to investigate along with challenges we seen.

Aims & Objectives

- Where are we now- Current Situation? Data collect
- How do we improve-Technology investigations
- Proposed and technical solutions
- Timeline



When Covid 19 arrived in Europe Berry global whom in most of their plants, manufacture materials for the health care sector quickly allocated Capital expenditure to many plants to invest in equipment that would directly have an impact on the pandemic. With lines already established in Europe producing non-woven filtration that is used in face mask production it was noticeable that the UK was week. Many plants were fighting to install equipment to support the pandemic but it was at our Aberdare site that put together the best business case to install a new state of the art filtration line. As historically, the Aberdare site had been a semi-automated plant producing Plastic tree protection this new line immediately give the plant a change to get one foot into the industry 4.0 age. As we at site had not before seen the filtration, technology we had no idea on how to implement the solution so we looked to our industry 4.0 team and installed Augmented real-time smart glasses (ARSG) in sites that had the other lines. This allowed us in times of Covid where we couldn't travel to have real time pictures, video correspondence and sharing of data that we had never know before. In a time where Zoom, teams and other digital platforms were expanding rapidly there hardware, software and personnel pre requisites we needed to think about in order to get the best benefit from our solution. We also had to think how we use industry 4.0 methods for real time performance management systems which would give us better control and allow us to grow as related to in a journal document written on production planning and control (Robert, M. 2022:[\"Available at: <https://www.tandfonline.com/doi/full/10.1080/09537287.2020.1810761>] 2022, P2). These two principles of ARSG and improved real time management systems would be critical in us sharing information with the other sites with the both principles providing us with some challenges. Managerial challenges, which will be, in large measure, due to human resistance regarding innovation and change. These non-technological changes are labelled management innovations, that challenges our company which we factor into performance measurement system implementation adapted to industry 4.0 along with machine capability. Our management system we have implemented is SCADA data gathering for real time performance which we plan to interact with our ARSG's in the future. In the below diagram our SCADA will sit in the new type of human-machine category which then leads onto the challenge of management innovation to nullify employees natural resistance to change (Robert, M. 2022:[\"Available at: <https://www.tandfonline.com/doi/full/10.1080/09537287.2020.1810761>] 2022, P5)



Augmented Reality Smart Glasses in the Smart Factory

IEEE Access(ANNA SYBERFELDT, 2017," Augmented reality. Augmented Reality Smart Glasses" p.1) journal defined pre Covid that Augmented reality smart glasses (ARSG) are increasingly popular and have been identified as a vital technology supporting shop-floor operators in the smart factories of the future. Not only will implementing ARSG's benefit the addition of the filtration line but it will also have the ability to support the Tree shelter business and provide instant support from engineers to operators. With Berry's introduction of industry, 4.0 to us back in the summer of 2019 I dint expect to be implementing one of the first tools showcase to us which was the ARSG's. We had an integrator hold a seminar with us explaining the benefits of ARSG's and showcasing some products that were in the marketplace but alongside that I had to carry out some web based research. The research I carried out the time of install has now elapsed but there are still lots of information similar on the internet much like what o would have used to research the ARSG's.

A blog similar to what I read on ARSG's was found on real wear's website and is aimed at providing a better understanding of ARSG's use during COVID. (COVID-19, 2020). It was important for me and Engineering managers from the other sites that we chose the correct ARSG's as there was to be a substantial investment and we needed to ensure it was right. After all we were in a pandemic and sharing of information between plant would be critical into succeeding and having a positive impact into the pandemic. Unbeknown to me working in manufacturing ARSG's were being used not just in healthcare but directly in the hospitals and real ware had some blog documenting how their glasses had been issued to hospitals allowing medical teams to keeping touch with each other between red and green zones within the hospital. My thought process was if this was working there then why wouldn't it work between our plants installing and running filtration lines across Europe.

Where are we now- Current Situation

As a team between plants, we set out where are we are currently at. The reality was that we had experts in filtration, non-woven technology specifically metblown technology and they were also in the process of installing a new line. With the Covid situation heading towards its peak, we couldn't travel so had to turn the digital world. Never before had we had to communicate with the French plants and rarely had we used Microsoft teams as a portal since we had been using IBM lotus notes as our platform with Office 365 being a new introduction so already we had a roadblock. Although the UK sites were lagging behind some of the European sites were more advanced so the situation was not too gloomy with offerings of support not too far away to help us improve.

How do we improve-Technology investigations

Real ware ARSG's use a web browser as the platform to use for live video streaming and although the teams portal was new to us it was available across all Berry sites and could share what the glasses were seeing between plants. For this to work we needed to ensure we could digitally share and communicate with site not just within Europe but also as far away as China and Mexico. Although in the short term we wanted to use our glasses for instant video we had in our minds a future vision of using the glasses in a simulation of the manufacturing floor. Other options for smart glasses include:

- Video—the real and virtual worlds are merged into the same view and the user's view is completely digital

- Optical—virtual objects are overlaid directly on the view of the real world
- Retinal—virtual objects are projected directly onto the retina using low-power laser light
- Hologram—virtual objects are shown in the real world using a photometric emulsion that records interference patterns of coherent light
- Projection—virtual objects are projected directly onto real-world objects using a digital projector

Proposed and technical solutions

Although we chose real ware there are many versions of ARSG's available and only a few years ago I tested the Epson version at the PPMA how at Birmingham NEC. There was a Weblog post (Blogs, 2018Blogs,[Online]Available:<https://www.proquest.com/docview/2076178284?parentSessionId=nfMiCW6BSaoJjfa9ZA%2BeEo8eQe217L3t3MSGJMVTVw%3D&pq-origsite=primo&accountid=130472>) written about Epson being one of the first companies to see value in the smart glasses platforms. Unfortunately, when I tested the Epson version I thought they would be a bit too fragile for the manufacturing site. At the time, there was also no mention of a digital smart factory or any way for us to have digital simulation of our factory. IEEE journal highlights that there was to be a 115% growth in ARSG's in the 5 years leading up to 2020 with 12.2 million units being shipped but it also highlights two key challenges that I noticed within manufacturing. The following paragraph is from IEEE journal(ANNA SYBERFELDT, 2017," Augmented reality. Augmented Reality Smart Glasses"p.2)

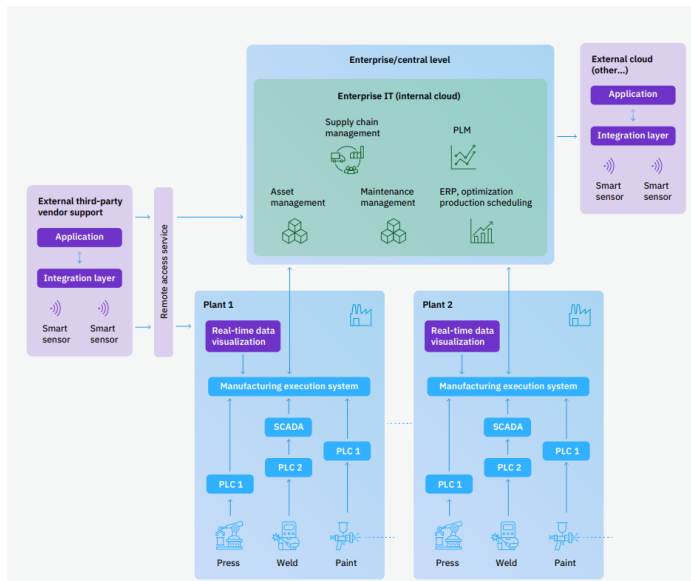
Today's products are primarily marketed either as general consumer products (typically targeting entertainment, sports, and/or gaming) or as professional office products (typically targeting product design). Second, the products are highly heterogeneous with large differences in design, technology, and functionality that make it very difficult to assess their strengths and weaknesses from a holistic perspective and to compare products with each other. This vast range of heterogeneous products makes it both complicated and time-consuming for a manufacturing company to identify the optimal product for its unique shop floor context, and this fact creates a threshold for adopting ARSG.

With our ARSG's they can easily be linked through a web browser which in the office environment works very well but within the depths of the manufacturing lines we had concerns about WIFI coverage, audio on the shop floor and Battery life. Battery life is another challenge highlighted within the IEE Journal stating the battery life of the reviewed glasses ranges from 1 hour to 8 hours. It should be noted that the battery life is highly dependent on how the glasses are used and how much computing power is consumed.

The bigger challenges with using our ARSG's we see will come at a later stage as we support our SCADA (Serge Bonnaud, n.d Available : <https://www.ibm.com/downloads/cas/M8J5BA6R> p. 8). A system with smart factory and digital simulation using live data from our ARSG's. New integrated technology with the introduction of our SCADA and the use of winCC platforms opens up a new world for us. The below diagram comes from an article from IBM labelled Industry 4.0 and Cognitive Manufacturing (S. Bonnaud, Available:<https://www.ibm.com/downloads/cas/M8J5BA6R> p. 7).

Although not directly related to ARSG's it is related to SCADA and smart sensors which will help us build our digital twin and then use the ARSG's and IBM is partnered with KUKA robots who we are currently working closely with as an integrator. It's also good to see the article focusing on digital transformation of production processes and looking at new opportunities to achieve levels of productivity and specialisation not previously possible with our older methods. The below diagram

on overview of where we aim to get with our SCADA system. If you take a look at plant 1 tab we have moved from PLC to SCADA and in the process of the manufacturing execution system using the live data. We are also using real time data to give visualisation of large screens showing performance levels against KPI's .



Project cost

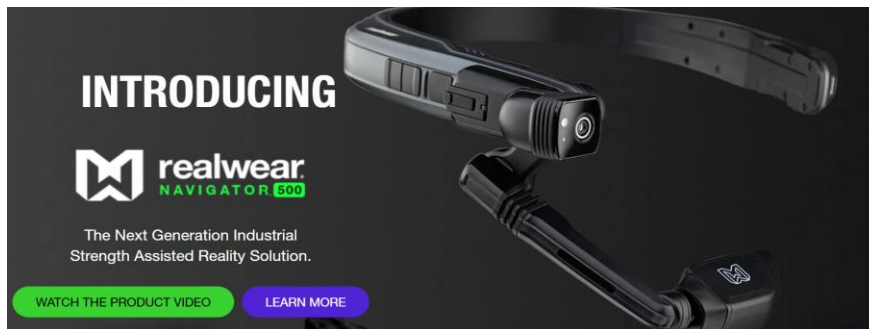
According the web based searched ARSG's can range from hundreds of pound to thousands of pound based on a wide criteria from battery life to connectivity. This coincides with the IEE journal where their research indicates:

The price range is really wide for ARSG the cheapest reviewed glasses cost \$499 (while the most expensive ones cost \$3995. We believe that for ARSG to be used extensively in the manufacturing industry and worn by virtually all shop-floor operators, the price must be modest so that companies can afford them.

In normal climates, this would have been a challenge to us as with a lot of Industry 4.0 technologies they generally don't come cheap so having a good business case together and selling the practices to the team helps promote buy in. Fortunately in our case Realware done a fantastic job of providing all this but we did pay towards the upper end of the price range.

Timeline

The last challenge we had was getting the system delivered in time and with limited resources. The pandemic didn't allow us to have on site support. Through the use of Zoom, Teams calls and teleconferencing we were able to set up, install and share knowledge so the ARSG's were set up and training given a timeframe that was accelerated with the needs of the Pandemic. Within just a few week we had received the ARSG's, tested them, carried out office based testing and starting using them to set up our new laboratory equipment.



Conclusion

Within my report, I have highlighted a number of industry 4.0 technologies we are in the process of using albeit we are still learning some of the principles behind these technologies such as:

- SCADA (we are using Win CC pro)
- Digital smart factories
- Smart sensors
- Robotics
- ARSG's

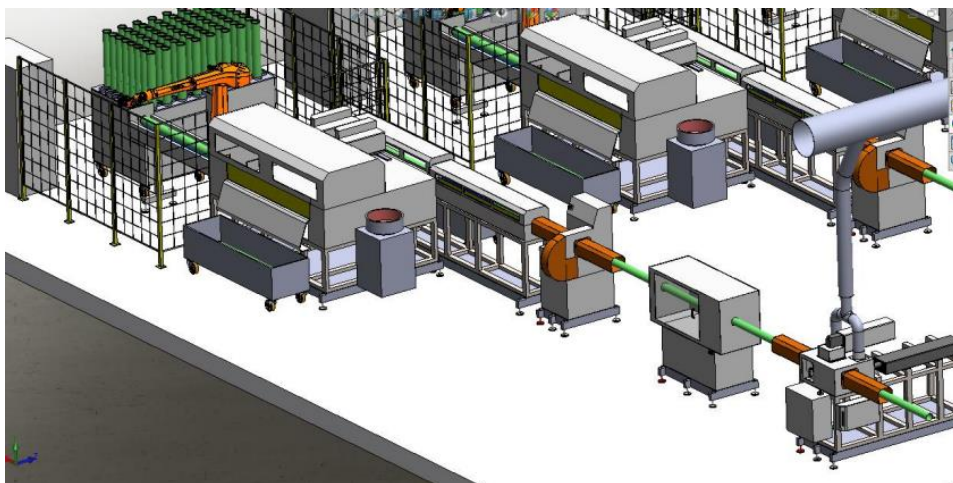
The latter technology was our first starting point on our industry 4.0 journey albeit with most machines upgraded to the point of the upper end of industry 3.0 technology i.e. PLC's and sensors. Since the ARSG's have been on site we have continued to invest into more technologies specifically our SCADA which at the time of writing is coming to fruition with the pilot line collating live data from our machinery. Already we have moved on from basic SCADA architecture such as HMI's, and end devices to portals, data tags and data hubs a lot of which are referenced in a new SCADA approach journal article (B. Vaduva,"One4all—A New SCADA Approach", P14 2022).

We expect to see challenges along the way with integration of our SCADA and then integrating our ARSG's into SCADA and our goal of the smart factory. I've highlighted the challenges we saw with WIFI coverage around using the ARSG's at the manufacturing shop floor especially within our insulated clean rooms and we expect similar things if we need to have any of our smart sensors and SCADA using 4G or 5G platforms.

Our Siemens Win CC SCADA platform (Siemens, n.d. Available at: <https://new.siemens.com/global/en/products/automation/industry-software/automation-software/scada.html>) has been developed by us and an integrator to suit our business needs. It's a totally expandable system and we chose this primarily as it is easily integrated with our PLCs that use Tia portal as the software. A Key factor for us was to ensure we have monitoring system for visualisation and operator control of processes, production flows, machines and plants. It allows us to have single-user station through to distributed multi-user systems and cross-location solutions with web clients. A challenge we do see later down the process is enabling a secure VPN as our internal IT department poses to have restrictions with this. A live view of our SCADA is below.



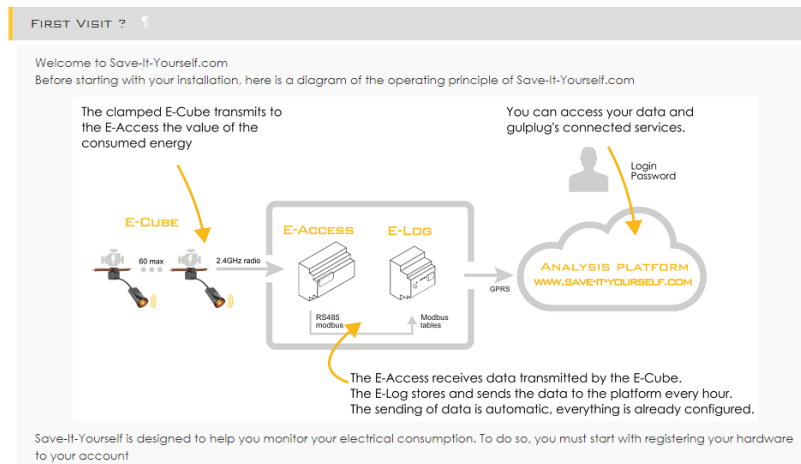
We are also a long way down the line in introducing Robots to our site as we await Capex approval. In the last 18 months we have collected a lot of data and put together a business case to introduce the Robots. We have partnered up with KUKA robotics who advised us on integrators that could deliver our solution. We are under an NDA with the integrator so I am unable to share too much but the below picture shows the robot in site for one of the phases. This would be a collaborative robot where currently we have two humans and the second phase would include an AVG robot to move product around. When we met with KUKA we spoke about ensuring the Robots can communicate with SCADA and it was at that point they introduced us to their smart factory and smart production (Robotics, n.d. Available: <https://www.kuka.com/en-gb/future-production/industrie-4-0/industrie-4-0-smartproduction>). KUKA uses a modern, Industry 4.0 architecture for networking the production cell using 4 differ net layers. The first being manufactured components, controllers, The industrial IOT platform thorough to the 4th layer which is the user interface.(Robotics, n.d Available: <https://www.kuka.com/en-gb/future-production/industrie-4-0/industrie-4-0-smartproduction> pp 6).



Smart sensors is a new concept we have not used just yet in the manufacturing aspect but we do use them for Energy monitoring. We use as system called Galplug (Galplug, n.d.
Available:<https://www.save-it-yourself.com/documentation.php>) Which is a cloud based system that collects data from our energy monitor (See below)

FAQ

FIRST STEPS ON SAVE-IT-YOURSELF



The Galplug data monitor uses smart sensors to transmit readings from Current transmitters directly connected to our machines using radio frequencies. The data is saved into campaigns on the cloud where we can take the data to show in graph or list formats. We also use similar sensors to collect temperature data with areas. Again this can be use to look for links between machine efficiency and temperature. These type of smart sensors is something we will look into at a further date with the aim of them feeding into SCADA.

As I conclude id like to highlight current challenge to industry 4.0 and that is the something I've not yet experienced but am expecting. As with all new technologies, parts are a premium and I'm currently seeing long lead times and increased costs on the most basic of parts. This is a challenge I say coming my way soon on our industry 4.0 journey.

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