

Sustainable Advanced Manufacturing Project. University of Sunderland.

CASE STUDY - Applying 360 degree/ video technology in manufacturing contexts.

Run by SAM in conjunction with Dyer Engineering Ltd. & SynergyVR.

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Premise

Background

Participating companies

Evaluative summary

    Virtual tour links

Feedback from participating partners

Agreed parameters

Process

    Technical process

    Challenges and practical planning

    Scanning process

Process extension

## **Premise**

The paper outlines a case study carried out in 2019. The original premise was to explore the potential for SME's to demonstrate their business and manufacturing performance by using 360 degree camera technology and scanning equipment on site.

Specifically explore the potential for full site 3D 'scanning' and "stereo" 360° 8K (Future Proof) video to be used in support of a range of outputs, including factory tours, staff induction, promotion of services, training and audit.

The project has been carried out between Dyer Engineering and SynergyVR, alongside SAM support for research and subsequent dissemination, demonstrating to SME's the process, work involved, implementation strategies, efficacy, ROI and potential application(s).

The 'real world' study demonstrates the effectiveness of virtual learning and training environments in accelerating learning, quickening production and lowering costs.

How they could be used, for example, to speed up the recruitment process, support a targeted candidate experience and attract the best talent.

As the case study progressed other opportunities for the application of the technology and process emerged.

## **Background**

Increasingly Virtual (VR) Augmented Reality (AR) and 360 video are being applied in the industrial, engineering and manufacturing sectors.

We are seeing a host of VR/AR solutions emerge claiming the capacity to transform or at least enhance everything from production training, bridging the skills gap left by an aging workforce, through to asset tracking, live process monitoring and operational delivery.

The technology offers a range of benefits including the ability to give individuals 360° demonstrations of products, training and acclimatisation, simulation and inspection in a virtual, hazard-free environment.

The capacity for embedding VR/AR training videos on machinery and production to support for example best practices; VR induction training and health safety videos.

**Participating company introductions.**

Host company. Dyer Engineering Ltd.

Dyer Engineering Ltd. Are an innovative group of fabrication and machining businesses with wide-ranging capabilities in the manufacture of metal components and structures.

Providing maintenance, repair and overhaul support services to keep customers equipment, facilities and processes running.

Their operation spans a diverse range of markets, working with various metals, with the ability to process small parts which can be picked up by the handful, through to large-scale structures operating in harsh environments.

Dyer Engineering have already undertaken an exemplar approach to digital transformation through their success in winning a national tender through Innovate UK to showcase industry 4.0 technology which adds to their suite of existing digital projects including, cloud migration, digital workflows, machine monitoring, data analytics and workforce engagement.

Scanning - "360 Tour Provider"

Synergy VR are a company with a North East base that create bespoke 360° immersive virtual tours, Virtual Reality (VR), Augmented Reality (AR), CGI, aerial drone photography + video, 360° 4K & 8K VR, Live Video, App development, and AI ChatBots.

## Evaluative Summary

Over the course of 2019, SynergyVR completed several visits to the Dyer Engineering site, culminating in production of a fully functioning, interactive 'virtual site tours' with a wide range of information relating to capability, process, and live performance data.

The interactive 'tours' are available both on standard screen displays, viewable through a web browser and also as a VR walk-through.

## Tour links

[Annfield Plain site Main Office and Top Shop](#)

[Harelaw site – Stainless Steel Site](#)

[Harelaw site – Paint Shop](#)

The outcomes arising from the scanning process have identified specific applications for the technology and areas of key benefit:

- On boarding of new employees
- Health and Safety tool to identify risks, fire exits, potential bottlenecks
- VR factory tour's aimed at prospective customers in industry & manufacturing sector, offering support of tendering process.
- Specific tours detailing building and content
- Solidifying confidence in existing customers and building a customer base
- Tour to expand knowledge of existing workforce to the overall operation and induction; including those who may have only worked in part of the business
- Facilitation of partial audits
- Education tool for STEM and graduates –i.e. could have specific tours with information about plant, operational machines & process.  
For example, remote mini-tour for A level plus students engineering undergraduates
- System integration with other emerging technologies:  
Asset tracking solution and discussion potentials to incorporate their technology with the VR as opposed to typical 2D PDF maps  
Live machine monitoring  
LPWAN Pallet space / material movement control

The tours produced were extremely detailed, resolution was such that all internal signposting and site layout can be inspected closely. Tours are hosted in the cloud behind a secure AWS system. The desktop/ browser system is intuitive and easy to navigate and added to this 'signposts' guiding the viewer were added. The tours support 'dolls house' and floorplan views, along with measurement, embedded highlights and an auto-play mode.

The tour links above are 'cut down' versions of full prototype tours produced earlier in the study, which included a large array of data and content.

The scope of content the tours can support makes the system very flexible; standard and 360degree video, audio and documentation (PDF's) can be embedded. As can web links including links to backend BMI data.

Resultantly the system represents a powerful way of disseminating and sharing a comprehensive array of visual information and data. Content can be updated quickly and content types can take advantage of standard platforms, i.e. YouTube.

The study demonstrated tangible benefits to the host company.

### Feedback from Dyer Engineering Ltd.

#### Challenges Faced by Dyer Engineering

Working in a competitive industry where the markets we operate in are subject to high levels of demand volatility, the need to service a wide range of customers is key to business stability. Although company turnover has remained relatively consistent, the mix of work and markets has changed significantly over a relatively short time frame. As such, the business has a pressing need to bring new customers on board.

The adoption of VR technology to provide factory tours removes any limitations on these being delivered in person. Our current process will consume two senior managers for a day, limiting our capacity to around four a month. There are also geographic limitations for prospective customers who some distance away, may not feel they can justify the time and cost for a visit and favour a more local but possibly less capable supplier.

VR tours allow an unlimited number of prospective customers access to our facilities where all our processes and capability can be showcased in an immersive environment. We do not expect VR Tours to fully replace face to face talks around future working partnerships, but they are expected to help make these more impactful as prospective customers will arrive self-educated and can then spend the time asking questions pertinent to their business's needs and challenges.

The primary use case was to develop a virtual factory tour to support customer acquisitions, however as the project progressed, the following additional applications / use cases were identified, some of which are not mutually exclusive from the primary use case:

1. Employee on-boarding process (familiarisation with the facility before the first day of work)
  - a. Staff welfare:
    - i. Toilets
    - ii. Canteen
    - iii. Assigned work area
    - iv. Site navigation
  - b. Health & Safety awareness:
    - i. Fire exits
    - ii. Fire points
    - iii. First aid stations
    - iv. First aiders
    - v. Identification and awareness of hazards around the site
    - vi. Live and dynamic KPIs

- c. Company information
    - i. Company history
    - ii. Overview of markets the business operates in and products it makes
    - iii. Past, current and forecasted business performance
    - iv. Meet the team
    - v. Overview of company values and culture
2. Allow 3<sup>rd</sup> party site surveying / auditing
- a. 3D scans were used by the IoT asset tracking company, based in Italy, to plan the installation of equipment; this would have normally required engineers to fly over and do so in person. The estimated project saving was £2,000.
  - b. Scans were also used to appraise suitability of our facility for the BBC to film a news story.
  - c. Other site auditing uses could include:
    - i. Equipment installation / moving
    - ii. Energy efficiency surveying
    - iii. Any other need for site visits
3. Generation of floor plans / images
- a. Floor plans were generated from the scans and incorporated into the IoT asset tracking solution, providing improved orientation through a natural, photographic view than a blueprint plan.
  - b. Ability to quickly screen shot any view of the factory for use in presentations or communication around an issue.

**Content example / potential application table:**

Content	Example	Use Case			
		Customer Acquisition	Employee On-Boarding	3rd Part Site Surveying	Education / STEM
Meet the Team	Short video of team member	X	X		X
Real Time KPI Data	Live ERP Data, Delivery OTIF?	X			X
Product Photographs	Finished Product	X	X		X
Health & Safety	Fire Exists, points, first aiders, major hazards		X		X
360 Video	Factory Tour				X
3D Scans	Asset Tracking Install Planning			X	X

Identifiable benefits

### **Remote site inspection and evaluation**

The use of the 3D scans for the planning and installation of the IIoT tracking removed the need for engineers to fly from Italy to the UK to perform a site survey, eliminating travel and accommodation costs as well as quickening the install program, saving at least two weeks. We estimate the IIoT asset tracking solution to reduce wasted productivity time to the tune of £4k a week, so just by accelerating the program there was a hidden saving of £8k, plus flight and accommodation.

The scans were used in the installation planning documents and later in the final solution for building maps as the photographic quality provided far better orientation than manually drawn 2D blueprints.

### **Impact of Services this Case Study Made**

A major obstacle in adopting emerging technologies, where there are few case studies, with only 'finger in the air ROI figures', is gaining support from the Senior Leadership Team, however the work produced by Synergy, creating a proof of concept, has been incredibly impressive and received so well, the team have committed to producing a polished solution to be showcased at SubCon 2020.

### **Impact on key business focus**

- I) Differentiation – the use of the VR tours indicates a willingness for Dyer Engineering to explore early adoption and innovation
- II) Increased capacity for customer visits – typically one a week which tie up two members of the senior team. Whereas a digital version, frees up key staff as well as opening up the reach to potential customers
- III) 2D 'birds eye' becomes part of the asset tracking (which in itself generates a 2D map)

### **Hidden Benefits**

- I) Similar companies in the sector on the 'Industry 4.0 journey' have engaged in informal 'knowledge transfer'
- II) BBC proposed feature on Dyer has been facilitated by the VR Tour which allowed remote pre-production

Financial benefit is difficult to calculate presently but will become clear over time.

## Feedback from Synergy VR

Overview of identified benefits by SynergyVR are:

- Proven value
- Establishing training protocols
- Support for training both on the move and remotely.
- Increased productivity; through lowering training time and an efficient Identification of further training requirements.
- Supporting integration of manufacturing, goods supply, asset tracking.
  
- Sectors: manufacturing, sustainable mining, potentially supply chain and logistics, asset tracking i.e Oil and Gas.
- Layouts – capacity to remotely study a space – site surveys and analyse where issues/ saving might be possible.
- Consistency of delivery avoiding variation of contracts – access points have been seen.
- Compliance and visibility
- Risk management.

Within the manufacturing sector, SynergyVR identify many applications for the scanning technology:

### **Health & safety, creating safer environments.**

Online training can be autonomous and support continuous learning that can be carried out remotely, refreshed regularly and allow for repeat testing to ensure employee understanding of key protocols, latest drills and fire exits are up to date.

Questionnaires can be embedded at key points on the tour, where there is a need for a specific understanding, responses to all of these 'key points' can be collected through 'jot form'. Individual and collective issues can be readily flagged up aiding early identification of on-going training needs.

This streamlining of Health and Safety should also result in savings in time and money and efficiency.

Proven (monetary) value is a key driver and if the tours can speed up, streamline Health & Safety training and implementation, then it can free up more employee time on the production line and productivity should increase"

Support for dynamic and flexible VLE, with minimal impact upon business operation.

Sustainable manufacture/ Manufacturing layouts; e.g. when a site layout is being updated a virtual tour can help the decision makers understand how they can more effectively make those changes. This can involve site surveys. A great deal of the groundwork can be carried out remotely, with time and cost saving.

Helps stop variations in contracts; site access points, obstacles are visible and the job parameters transparent with the 'full access' the tour provides.

Logistics and supply chain.

Asset tracking, e.g. oil & gas operations a particular issue is the wrong parts being delivered to the rig. The system/ tours can minimise errors.

## **Agreed parameters**

Prior to project commencement SAM agreed to the terms of support offered to Dyer Engineering; 'New to Firm Process' using 360deg scanning to create 'virtual site tours' of plant and facilities. SynergyVR agreed to partner in the case study and initial parameters were agreed between partners. This essentially involved Dyer Engineering facilitating SynergyVR with access to key locations, and provision of all information, data and videos to be embedded in the tours

SynergyVR to complete the technical process of producing the VR tours, all post edit and publishing of these.

All materials and outcomes to be made available to SAM for the purposes of the Case Study. SynergyVR and Dyer Engineering also to retain right to access the content and materials arising from the study.

## **Process**

Timescale

The scanning process required several visits. The first site visit to Dyer Engineering Ltd. was on 08-02-2019. After which there were a further series of site visits.

## Technical Process

The study involved three elements:

- i. Scanning the Interior of the factory units – using a Matterport Pro2 camera (\*a)
- ii. 360 video walkthrough – with subsequent voiceover - using an Insta360 Pro2 camera (\*b)
- iii. Aerial video of the site – using a Maverick Pro2 Drone (\*c)

These three elements were combined into a unified resource.

Completion of these used the following equipment.

(\*a) Matterport Pro2 Camera: This camera scans an area and embeds measurements (accurate to 0.1mm) into the assembled footage. This data can be pulled out of the back end and injected into CAD. It supports creation of OBJ files.

The 3D 'doll's house' it creates provides an easily comprehended visual resource.

It supports 'real-time updates' which can be edited online, as it is hosted on the (Matterport 360 2) cloud service. Information can therefore be quickly added, edited or removed from the tour.

<https://matterport.com/pro2-3d-camera/>

(\*b) Insta360 Pro2 – 4k-8k (futureproof video). Records 8k 360 video (stereo) allowing for production of walkthrough virtual VR video tours and is multiplatform.

<https://www.insta360.com/product/insta360-pro2/>

(\*c) Drone: Maverick Pro shoots 1080p footage. Is flexible and manoeuvrable. This allowed aerial footage of the sites which gave context to the other 360 footage.

## Challenges and practical planning

Dyer Engineering have two sites, at Annfield Plain and Harelaw. These contain multiple equipment and process in the machining and fabrication of metal products. There are multiple buildings across two facilities, with a combined area of 100,000 sq feet. Initially the scanning process focussed upon the Annfield Plain site. Security and Health & Safety is paramount and therefore required planning in respect of how to negotiate this. It was agreed therefore that the optimal time to complete the scans would be when the plant was clear of operatives; generally Friday afternoons, but also subsequently on Saturdays. There was no down time as a result.

The scale of the plant necessitated multiple visits.

The first site visit revealed that the tour would involve capture of potentially sensitive material; the process involves uploading the VR scans into a 'cloud' based software assembly, which could potentially compromise the confidentiality of specific process that Dyer were producing.

This matter was subsequently resolved by further discussion.

Draft 'edits' of the tours were produced and shared with Dyer Engineering and SAM for initial review. A full schedule of scanning sessions was then agreed upon and these took place on multiple occasions over March – June end 2019.

Subsequent recordings also included videos with heads of department, walking tours and voice over.

Key points:

*No down time.*

*Any sensitive material was edited out & deleted.*

*Health & Safety was Dyer's responsibility – including clearing the space prior to the shoot.*

Minor issues

Size of units/ operations presented no issues for SynergyVR.

On the larger manufacturing floor there was too much traffic on one occasion; with a clear run it could have been completed in 2 hours on a Saturday.

Working in segments was not ideal.

## **Planning**

Naturally in a large operation, different sectors and those involved specific production process, will have differing internal priorities. Retrospectively, clear lines of communication are needed, so that everyone was aware as to why Synergy were there. Some operatives expressed concern as to how the scanning process might affect their immediate operation. Again can be negated by 'out of hours' access.

A key lesson is that the time required for the scanning process can be considerably reduced, if it can be scheduled for a time when the location(s) is clear of personnel and normal operations are not taking place. Therefore 'out of hours' access becomes desirable, both in respect of job turnaround and production cost.

SynergyVR were provided with everything they needed in respect of facilitation including Health and Safety. All of SynergyVR's equipment was illuminated.

Locations: operational challenges

Main challengers were:

1. 24 hour operation in some buildings, so scanning had to take place on weekends
2. Some work was MOD so had to be removed
3. Preparation to ensure the areas were clean and tidy; hard to get resource to do this when working to deliver product.

### Scanning and editing process

Matterport

Involved taking a scan 1 & 3 metres between each hot spot for depth of content, in order to create a true granular 3D environment. In order to create a seamless environment, this is what the software ideally needs for alignment.

Some areas are less important and require less.

Using a lasers as little UV light as possible is ideal, as this can adversely affect the device lasers. This also underpins the need to use the drone for the outside footage.

All content uploaded after the scans are complete.

A large site requires a sense of scale using an 'interactive map, this is supplemented by using drone footage for aerial footage.

Content can be standalone or cross –embedded, so for example the drone aerial footage can be embedded in the VR tour.

Sections of the footage can be 'extracted' for specific purposes, for example a digital brochure, with interactive tours for each area.

Insta Pro 2

Record video, voice overs and be post added and this is then hosted on YouTube (or Vimeo) as 360deg Mp4. As such it becomes 'platform agnostic' requiring standard web browser support without 3<sup>rd</sup> party plugins being necessary, and effectively offers free hosting to the client.

It can also be produced offline, for use on tablets, VR headsets – including Oculus Go and at the most basic level, Google Cardboard. This makes it 'multi-platform agnostic. By not requiring an internet connection it makes it useful for trade shows.

The post production process is far more involved (than the Matterport).

Software including Mystica VR, Adobe Premiere Pro. In post edit this supports inclusion of motion graphics, animation, watermarks, call to actions, AR chatbots, and lead generation.

Also if necessary faces can be blurred/ pixelated to force anonymity.

There are no ongoing costs.

Site plans whilst useful are not essential, specifically in establishing scale.

Site survey however are key – site plans are useful but secondary.

### Additional note on specific application of the virtual tours during the case study

As indicated earlier the scanning process streamlined the planned integration of an Asset Tracking system that Dyer have procured from a company in Italy: Thinkin.io . The availability of the scans enabled the company to pre-plan what was required for the Asset tracking integration, prior to installation. The maintenance team were able to remotely refer to the

scans to plan positioning and height of key antennas/ sensors required. As such it saved on flights, accommodation and man hours.

*"I confirm we can carry out the installation we can conclude cabling and aerial install. In terms of the visit and to speed up the process, given that it may be a little tight to cover both sites, (using) the previous scans have (devised) a pretty accurate deployment plan. Our suggestion would be to plan the visit some time over the coming month, (access to the scans) was very useful" correspondence from thinkin.io*

### **Process extension**

As the process developed other avenues and opportunities emerged and resultantly the project expanded beyond the original agreed scope.

Dyer Engineering intend to take the 'virtual tours' beyond the original parameters of the case study. By way of indication the plan is that a number of embedded videos, documents (maintenance manuals for machines), photographs/ images, BI reports (live ERP Data) and live video feeds from CCTV will be included. Other ideas considered included extended 'meet the team' videos and audio.

SynergyVR provided access so that a large part of content can be uploaded directly by Dyer Engineering.

It is anticipated that further extension of the virtual tours will potentially benefit Dyer Engineering:

"We will only be able to ascertain benefits of the VR tour when launched at SubCon 2020. The expectation is that we would be one of the first manufacturing companies to be delivering a remote, immersive tour of our facilities, which we believe to be a powerful differentia and position ourselves as a forward-thinking company, embracing emerging technologies to deliver an excellent customer experience.

"The employee on-boarding will save half a day per new starter as they would not have to do our normal induction process.

At an average value add rate of £19 / hour, this would be £76 / new starter as a minimum.

"A new employee would also have already orientated themselves around the site, so there would be an improvement in their productivity, whilst it is difficult to exactly quantify this, an estimate may be 10% over the first month.

"There would also be an expected improvement in staff retention by having a very welcoming and informative on-boarding processes."

Richard Larder. Dyer Engineering Ltd.

### **Next stage**

- I) It will be extended into resource planning – using embedded assets
- II) New customer acquisition questionnaire will be embedded "How did you find us"
- III) Integration of 360 deg footage (drillbit) into the tours
- IV) Standard operation sheet could be delivered instead by training videos

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