XR STRATEGY FOR POWERED ACCESS TRAINING

December 2018

A primary area of focus identified by the IPAF Board is:

Developing and implementing a strategy to optimise the use of virtual reality (VR), simulators and our expanding eLearning offer, while integrating the Smart PAL Card into systems to deliver a full digital experience.

Source: Section 2 of IPAF's three-year strategic plan 2018-2020

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ONE POSSIBLE FUTURE

Ten years from now, what might be the process for obtaining an IPAF PAL Card?

Ethan, a fitter, has little knowledge of powered access or MEWPs and will be required to use them as part of his new construction job at a steel erector firm in Kansas, US. As part of his training, he must obtain a valid IPAF PAL Card. He visits the IPAF website to learn more about training, what type of MEWP he can be trained on and where his nearest training centre is.

As a novice operator, Ethan decides that the virtual classroom will be his best option and uses his VR glasses to enter the training environment from home. A virtual IPAF instructor is on hand to guide Ethan through the training and answer any questions that he has as he goes through the course, which takes him 3.5 hours. Ethan's retinas are scanned to ensure he is who he says he is, and to verify his identity throughout. Ethan passes the theory test and is then offered a huge range of places in which he can use an IPAF Certified simulator to undertake his practical training and testing. On arrival at the facility, Ethan inputs his code in the lock and enters. The simulator assigned to Ethan shows his name on it. Ethan dons the headset, gloves and other haptic equipment and steps into the simulator. The practical training is guided by the same virtual instructor. The equipment Ethan is wearing along with the physical feedback and lifelike graphics make the experience quite daunting for a novice. There is no time limit for practice and training, but it takes Ethan three hours until he feels comfortable enough to select the test options. During the tests the simulator monitors eye movements and control functions to ensure that Ethan is checking in the direction that he should be, operating smoothly and responding correctly to stimuli. Ethan passes the course and is awarded a virtual PAL Card that corresponds to his iris.

On the construction job site, before Ethan can use a real MEWP, Ethan's iris is scanned by the machine and it verifies that he is qualified to operate it. It also records the time that he takes possession of the machine, where it is and the duration that it is used for. Ethan's virtual PAL Card also records the machine type, model and hours he's used it. This happens every time Ethan uses a machine over the next four months. Ethan is then required to undertake a job that will involve working near to overhead structures and negotiating small openings, so Ethan decides to take IPAF's advanced operator course, PAL+, to improve his skills. Ethan registers for this training online and visits the same facility where he undertook his initial training. Ethan then spends four hours practising the complex manoeuvres required to pass the test, having selected the exact building that he will be working in via the BIM modelling menu. During the practice, Ethan learns how to navigate the complicated scenarios and avoid crushing hazards or becoming trapped by moving a control too quickly or selecting the wrong control. Ethan takes the test and passes,

by a fine margin, and is advised in his post-evaluation notes to be more vigilant when moving the MEWP platform backwards and down.

The next time Ethan uses a machine it recognises that he now has his IPAF PAL+ and reminds him that he should be careful when moving backwards and down, which he is. He completes his work in the real building without incident and decides that next time he has a complex job coming up he will visit the VR facility to familiarise himself with the building and practise the manoeuvres in a safe environment.

Four years and six months after his initial test, Ethan receives a reminder that his IPAF PAL Card will expire shortly and is asked to return to the VR facility for re-testing. Ethan has by now logged hundreds of hours of machine use on a cloud-based database, and is quite an expert. He selects "test only", passes with flying colours and is back out with a renewed five-year virtual IPAF PAL Card within an hour.

OVERVIEW

In response to the primary areas of focus identified by the Board, published in the IPAF Three-Year Strategic Plan (2018-2020), this document outlines a strategy to take advantage of new extended reality (XR) technologies, including virtual reality (VR), simulators, and the technological advancement of the PAL Card. As of 1 January 2020, all valid PAL Cards will be Smart Cards and digitally enabled.

IPAF launched an industry-wide consultation process on 1 January 2018. One element of the consultation involved the use of a virtual reality simulator on loan from Serious Labs, which was taken to events in the UK, France, the US, Malaysia and Spain, and will be taken to other events in 2019. Feedback from users trying this technology is vital to help us understand what role these machines can play in the industry.

Running alongside the verbal consultation and discussions, IPAF created an online survey to gain wider feedback on the use of new technologies and the role IPAF should take. The survey was available in eight languages and all the responses were carefully analysed and have been used in creating this document.

It is vital that IPAF ensures that all XR techniques are understood and appropriately used by the industry to:

a. Ensure that operator and other training is as good as it possibly can be;
b. ensure that IPAF retains its role as the leader in high-quality MEWP operator and supervisor/manager training.

This report was created by a workgroup consisting of Chris Greenbank, Paul Roddis, Giles Councell, with additional input from Tony Groat, Raymond Wat, Roger Schaffner and Reinhard Willenbrock. It was approved by the IPAF Council in October 2018.

Tim Whiteman
IPAF MD & CEO
30 November 2018

SCOPE OF THE STRATEGY DOCUMENT

This strategy document is to be used and adopted by IPAF to ensure IPAF's training programme keeps up to date with the introduction of new technology and to take advantage of all XR technology to enhance IPAF's training and the core objective of promoting the safe and effective use of powered access worldwide.

IPAF acknowledges that the world of technology is fast-moving, and this is evident with the rapid development of MEWP simulators in only 18 months, which is both astonishing and exciting. As such, this document can only include technology that is available now or in the immediate future. Where possible, it will identify areas that IPAF needs to be involved to keep abreast of the technological developments and be able to leverage them when viable.

To effectively achieve the elements of the strategy document, it is likely that additional staffing resources would be required. Additional resources have been identified below.

It is recommended that this strategy is reviewed and updated annually.

This document brings together data from the survey, feedback from stakeholders and users at events and IPAF staff.

WHAT IS XR, VR AND AR?

These are now widely used terms in the technology sector, the most recent being XR, which stands for Extended Reality. XR refers to the spectrum of experiences that blurs the line between the real world and the simulated world. The technology immerses the user through visuals, audio, haptic (touch) and potentially olfactory (smell) cues. The two main types of XR are virtual reality (VR) and augmented reality (AR).

Virtual reality (VR) visually takes the user out of their real-world environment and into a virtual environment, typically using a headset for viewing coupled with handheld controllers to navigate the virtual space. Whereas augmented reality (AR) overlays digital objects (information, graphics, sounds) on the real world, allowing the user to experience the relationship between digital and physical worlds.

CONSULTATION SURVEY RESULTS

Almost 200 responses to IPAF's survey were received, which is statistically significant. From the responses, a common view emerged that this technology can only make the industry safer and that IPAF, as a global leader in training and the safe use of powered access equipment, should be at the forefront of the use of XR in the powered access sector.

The results of the survey showed that, even though fewer than half of respondents have tried a VR simulator, a majority agreed that VR could be used to aid training in high-risk scenarios, such as those covered in IPAF PAL+ training, familiarisation and refresher training. Respondents did not generally believe that the technology could be used on its own in the current training programmes, and the majority expressed concerns that this technology does not give the same sense of environmental conditions or can effectively simulate actual "operator anxiety" when elevated. However, a common theme among respondents was that it might be used to help get novice operators quickly up to speed.

When asked if MEWP VR simulators could replace practical training, the response of respondents that had never been on a simulator was just 37% in favour (yes and don't know); this increased to 52% for those that had used a simulator. IPAF believes that the market would not currently accept a PAL Card being issued to an operator who had never been tested using a real machine. However, this would not apply to advanced training conducted after having successfully passed initial testing on a MEWP for the basic operator-level qualification.

SUMMARY OF FEEDBACK

Feedback was also collected when the simulator was at exhibitions and events. Operators, IPAF instructors and other users have had the opportunity to try this technology, as did those who were unfamiliar with or who had never before used a MEWP. As with the survey, anecdotal feedback has been that this technology can only make the industry safer. Prior to using the simulator, many users have been sceptical of it; a point of view which has tended to change dramatically once they have experienced it for themselves. This has often resulted in the user leaving with higher expectations of what this technology can do.

At one event, school children aged 13-14 had the opportunity to try the simulator, and as with other users had a very positive experience. Observing this younger generation operating a MEWP, albeit a virtual MEWP, it was astounding how quickly they picked up the controls and were able to control the machine smoothly. The younger generation's constant use of technology in every-day life is something the industry will need to adapt to in the future.

SHOULD IPAF DEVELOP ITS OWN TECHNOLOGY?

Responses to the survey suggested that IPAF should not become engaged in trying to develop this technology. Looking at the available resources within IPAF at present and the pace of development of this technology, it is advisable that IPAF should not attempt to position itself as a competitor in this sector but rather that IPAF seeks to work with developers and ensures its guidelines and advice are at the forefront of development, providing a framework against which others can measure progress.

To do this, IPAF should approve or accredit the technology, including products like MEWP simulators and the software they use. This could be achieved by creating a tiered rating system, whereby companies submit their product to obtain IPAF approval. This way IPAF ensures the technology is relevant to its members and the wider industry. It can help drive forward innovation and development with different tier criteria. Some simulators or VR systems are very simple; it is important that users understand the capabilities and potential applications of different systems.

A suggested criteria matrix based on the current spectrum of technology could be:

	Visual feedback	Auditory feedback	Physical feedback	Realistic physical input	Realistic physical feedback
VR & simulator (with motion/haptic feedback)	Y	Y	Y	Y	Y
VR & simulator (without motion/haptic feedback)	Y	Y	Y	Y	N
VR (with motion/haptic feedback)	Y	Y	Y	N	N
VR (without motion/haptic feedback)	Y	Y	N	N	N
AR	Y	Y	N	N	N
360° videos	Y	Y	N	N	N

Once these criteria have been defined, IPAF would need to commit staff resources to conduct accreditations and define costs for getting a product accredited. It should also be considered whether this accreditation would be open to those who are not IPAF members.

HOW CAN XR TECHNOLOGY BE USED IN IPAF TRAINING?

XR technology aids memory retention and recollection ability, compared to viewing videos or text-based materials. A study by Clark & Paivio in 1991 found that memory is anchored and made stronger when there is increased multi-sensory and emotional input.

This was again demonstrated in a recent study, in which participants were presented with either a 360° VR video or a 2D video of a motorcycle ride, followed 48 hours later by a memory test. The results showed that the VR group performed twice as well as the 2D video group in the memory recollection test (Schone *et al,* 2017).

As studies such as these show, there are substantial reasons to use XR to improve training. No other technology has to date shown as much potential to revolutionise the way IPAF provides training candidates with the knowledge and skills to stay safe.

One concern raised by some respondents is that exclusive use of XR for operator training could create "a sense of invincibility", as operators are simply able to "reset" the machine after having an accident.

IPAF should not attempt to enforce the use of XR technology in its training courses, however it should neither prevent the use of this technology to enhance training nor do anything to hinder the development of products that could. XR should:

- Complement IPAF's guidelines and advice for the safe use of powered access, including MEWPs and MCWPs;
- enhance learning for operators;
- enhance safety for operators.

Potential areas to develop included in current IPAF courses are as follows:

OPERATOR TRAINING

VR simulators can currently prepare candidates effectively for practical testing. It is not inconceivable that, as they develop, they might replace practical testing in future.

It is certain that AR would enhance pre-use inspection of MEWPs considerably, this could enrich theory and practical training elements.

Interactive 360° video can contextualise a huge range of hazards associated with MEWP use. These would be a cost-effective and high-benefit change that could be implemented relatively quickly.

REFRESHER TRAINING

VR simulators could play a major role in refresher training, to test the ongoing competency and skill of an operator. The operator would already hold a valid IPAF PAL Card, having previously been physically assessed on a real machine.

It is also reasonable to imagine a situation where candidates for refresher training would scan their smart or digital IPAF PAL Card on a simulator prior to being assessed and on successful completion this could be updated accordingly. This would alleviate the need to produce a new physical card, and all data would automatically synchronise between IPAF and the holder's PAL Card account.

MEWP OPERATOR RENEWALS

As with refresher training, VR simulators could play a major role in the renewals of a MEWP operator's PAL Card (provided they have fulfilled the minimum requirements to complete a renewal course). As they had originally been assessed in a practical test using a real MEWP by an IPAF instructor, then it would be acceptable for them to renew using a simulator. It is not inconceivable that to renew a PAL Card, simple eLearning followed by an exam and an assessment in a simulator would be enough to update a virtual PAL card. This is likely to have a significant positive effect on numbers of renewals of IPAF PAL Cards, making it more time and cost-effective to do so.

PAL+ TRAINING

As suggested during the consultation, the use of a MEWP simulator would enable an operator to experience high-risk scenarios and would be a suitable alternative or could complement the current IPAF PAL+ training course. If a simulator could challenge and test an operator and provide realistic physical input, realistic physical feedback, and fulfil all the objectives of the PAL+ practical test, it would be a commercially viable option for IPAF-approved training centres to offer this option.

To ensure consistency across training, IPAF could mandate a certain level of simulator accreditation that would need to be achieved before operators could gain a PAL+ on a particular product or machine type.

This possibility could be attractive for training centres in the UK that do not currently offer IPAF PAL+ owing to the size and complexity of the current PAL+ course, and the types of equipment required to carry out physical assessment. It could also provide an opportunity for training centres globally that do not currently offer any advanced MEWP operator training in certain countries or regions to begin doing so.

LOAD AND UNLOAD

VR could enhance the hazard-spotting and decision-making elements of the course, allowing operators to see the result of errors of judgment, ie simulated overturns.

AR could enhance inspection elements of both the MEWPs and plant to be loaded, as well as of the vehicles on which the MEWPs or plant are to be loaded.

It is already planned to utilise enhanced 360° videos in the updated version of the IPAF course.

MEWPS FOR MANAGERS

As a theory-only training course, the use of 360° videos is being used to enhance the candidate experience in the upcoming release of the course.

The course does not require the candidate to have previously operated a machine nor will it require them to do so, however, a VR simulator could be used to give non-operators a sense of operating a MEWP.

AR could bring a virtual machine into the classroom for candidates to explore.

HARNESS

XR technology would clearly offer a richer and more fulfilling experience and would enhance any theoretical elements in the same way as the other courses. Practicality, it would not be suitable for the hands-on parts of the course at present.

PDI AND CAP COURSE

AR technology would clearly offer a richer and more fulfilling experience for potential and existing engineers. AR would allow engineers to explore components within the machine, showing areas that are prone to wear or corrosion which would not normally be accessible on a real machine, without disassembly.

VR would enhance any theoretical elements in the same way as the other courses.

MCWP

MCWP courses could be enhanced by using VR/AR and 360° video in the same way as the MEWP courses.

NEW IPAF TRAINING COURSES & PROGRAMMES

In addition to the inclusion of XR in the existing IPAF courses, there is ample scope to create new courses or additions to IPAF's existing training programmes, for example:

OPERATOR EXPERIENCE BUILDING

Using VR, IPAF should look at the possibility of developing or accrediting a training programme to help new and inexperienced operators gain valuable operator time on a range of machines. This should link to their PAL Card to log the hours or, if they don't hold a valid IPAF PAL Card, there could be a mechanism to allow them to log hours on an IPAF account then have those added to an IPAF PAL Card digital log once they have successfully completed their IPAF training. This may be an advantage in places where IPAF training is less readily available or known about, for instance in emerging markets where there is sudden and rapidly increasing need for MEWP operations.

OPERATOR COMPETENCY

This is a protocol that is already being employed in the industry, mainly by large construction or infrastructure firms, and involves the use of VR simulators currently available to build familiarisation with a machine or task, and demonstrate competency and safe practice, before allowing operators to use a real MEWP on site.

IPAF should work with simulator manufacturers to guide the development of appropriate tests and scenarios and to provide the system to record these tests on an operator's IPAF PAL Card, to allow future checks by their current or future employer. These tests would need to be conducted on an IPAF-approved simulator, and could be tailored to the type of operator and their current licence categories.

An investment would be needed to make changes to the PAL Card system to allow the storing of additional data, this can be part-funded by charging a small fee per test and the continued accreditation of operator competency courses.

INCIDENT RESPONSE

IPAF should consider developing a new course for incident response. Using VR and other XR technology, operators would learn how to respond to unexpected scenarios, eg subsidence, an overhead collision, a situation requiring a basket-to-basket rescue etc

OTHER TECHNOLOGY-RELATED OPPORTUNITIES

Another area that could have significant benefits for our training centres is the use of our Learning Management System (LMS) for massive open online courses (MOOCs). A theory session is held live online and candidates sign up to take part. By doing so, they will have the benefit of explanations by an instructor and can also ask questions live to be answered by the virtual instructor or perhaps another instructor who is dedicated to monitoring and responding to questions.

OTHER SAFETY ADVICE AND GUIDANCE

IPAF needs to enrich the safety advice and guidelines around adopting technology such as VR/AR and 360° videos, so that managers and supervisors can decide what uses and applications are appropriate. This will also give instructors a framework of reference and guidance and reassure operators that they are being asked to demonstrate competency, familiarisation or rehearse certain procedures and scenarios for the benefit of their safety and efficiency on site using real machines.

CONCLUSIONS AND RECOMMENDATIONS

There is no doubt that the use of XR in IPAF's training programme can bring many advantages. The options need to be considered each time a course is updated or created. To summarise:

- IPAF should not attempt to develop simulators but should work with manufacturers to aid in their development.
- IPAF should approve or accredit simulators for different uses if they meet proposed tiers of minimum requirements.
- IPAF should use and develop VR/AR models and 360° video scenarios in its training.
- The market is not ready to accept that operators could be exclusively trained on simulators and is likely to continue to require a practical test on actual machines before issuing at least the basic level of operator qualification.

The areas to focus on are:

- Accreditation of XR technology;
- Virtual PAL+ course;
- Virtual refresher courses;
- Virtual renewal courses;
- Operator competency testing;
- Developing new courses that are best delivered in XR.

The recommended next steps are:

- decide on staff resource allocation to implement the IPAF XR strategy;
- define an accreditation scheme;
- conduct virtual PAL+, refresher and competency trials;
- Consider advancements to the IPAF PAL Card system and the creation of a digital PAL Card.

APPENDIX A: IPAF OUTLINES CONSULTATION ON VIRTUAL REALITY AND PLATFORM SIMULATORS (PRESS RELEASE)

4 January 2018

A global consultation is to be launched by IPAF to establish the possibilities for powered access training and safety guidance afforded by new technology such as virtual reality and platform simulators.
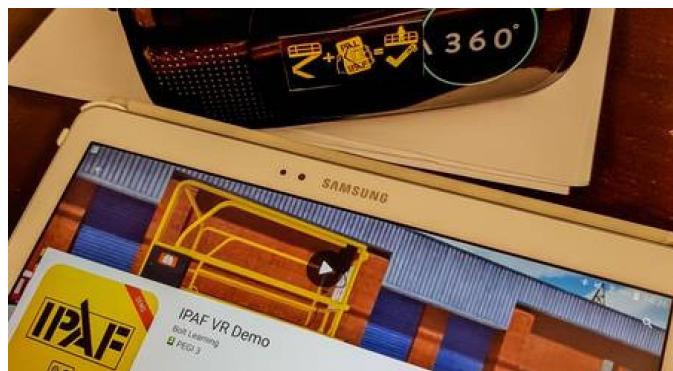
VR is now a reality and IPAF's worldwide network of almost 700 approved training centres are looking for guidance on how best to incorporate VR and the newest generation of simulators into training the more than 175,000 operators that obtain a PAL Card every year. IPAF will launch a major consultation exercise with all training centres to see how best the technology can complement IPAF's existing programme.

For many years simulators have been used as an effective means of training pilots in both the military and civil aviation sectors and have also been used to drill workers in high-risk environments such as the off-shore oil and gas industry. As technology has become more sophisticated, mobile and affordable, the use of simulators and VR is becoming more established in the Mobile Elevating Work Platform (MEWP) realm.

IPAF's mission statement is to promote the safe and effective use of powered access worldwide. With this in mind, IPAF believes the use of VR with simulators for training MEWP operators is a positive development and should be welcomed.

Tim Whiteman, IPAF's CEO & MD, says: "There are lots of complex and potentially dangerous situations that can be experienced in a totally safe environment in the virtual realm that would be difficult or even impossible to recreate safely in most other training environments.

"Our aim is always to find ways in which modern technology can complement our existing eLearning and classroom-based training for operators and managers. Who better to take advice from than the more than 1,000 accredited IPAF instructors around the world?

"The consultation exercise will be addressed to all relevant stakeholders within IPAF's membership – manufacturers, training centres, rental companies, contractors, simulator developers and operators.

"IPAF welcomes this technology and immediately endorses the use of VR simulators as a good training tool for MEWP operators when used in addition to the current IPAF theory and practical training programmes."

APPENDIX B: A NOT TOO DISTANT FUTURE?

IPAF released a news story on 1 April 2016 about implanted RFID chip PAL Card trials which was published on www.Vertikal.net and is reproduced below:

IPAF chip implant

The International Powered Access Federation (IPAF) has completed successful trials on an implanted Smart PAL Chip which it expects will help reduce fraudulent machine use, the fraudulent use of a PAL Card and improve convenience for certified operators.

The federation believes that it is one of the very first training certification schemes to offer this ground-breaking technology, which piggybacks on the successful implementation of its smart card system which became standard on all PAL Cards issued since January 2014. There are already around 210,000 valid Smart PAL Cards in circulation.

A microchip, similar in technology terms, to that used in the PAL Smart Card, is inserted under the loose skin of the forearm, just above the wrist, or in the fleshy area between the thumb and index finger. The tiny chip - roughly the size of a grain of rice - is injected- or rather 'implanted' under the skin in a process that takes a minute or two from start to finish and can be carried out by any IPAF trainer who has received the relevant training.

The sanitized chips are delivered pre-loaded in a disposable injector, ensuring that the entire process is both clean and easy to administer. The preliminary tests have been carried out in Switzerland, where over 130 operators are now equipped with them. The first one was implanted nine months ago in the wrist of IPAF research & development manager Rupert Douglas-Jones, who has been testing it ever since. "Embedding the chip was painless and is one of several ideas that we have on test. It is very convenient and certainly beats all of the other ideas that we are working on in this area" he said.
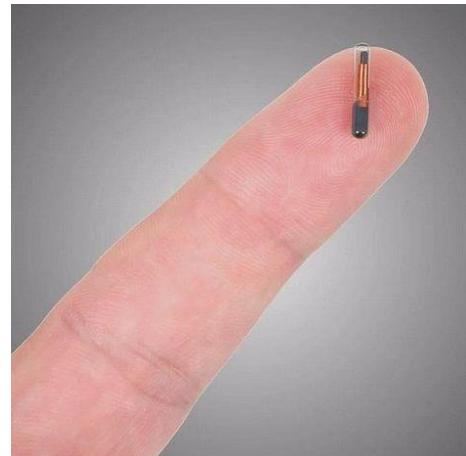
An operator equipped with an internal chip simply waves his hand/arm past the standard reader installed on a machine in order to activate it. Alternatively, job sites can install PAL Card readers at the entrance, or use a compact handheld device - allowing those equipped with the chips to be approved to operate the relevant equipment as they arrive on site. The process is quick and avoids the need to remove a card from a wallet or pocket.

The installed chips have also been tested through all airport security systems and are so small that they do not set off any scanners, or even cause issues with the latest full-body scanners. Operators who have the chip installed claim that it has been incredibly liberating, eliminating any chance of losing the card, leaving it behind when going to work or damaging it. It also means that when working on sites where they have concerns about personal security they do not need to take their wallets out. Conversely, some high-security sites, where visitors or employees are not permitted to take any personal effects in, are expected to be particularly welcoming of this new technology.

The chips will have the same five-year life as the regular PAL card but can be reactivated externally, when the relevant refresher training course has been passed. This makes renewal simple and easy. Should an operator wish to have the chip removed, the process can be carried out by those certified to insert them and takes roughly five to 10 minutes.

IPAF chief executive Tim Whiteman said: "When we added the microchip to the PAL Card to create the Smart card, our supplier mentioned that this new technology was on the way and asked if we would like to be one of the pioneer companies in its test programme. It just seemed like a perfect opportunity for us to move forward and demonstrate the innovative nature of our industry. The basic technology is not new, it has been used to tag dogs, horses and other mammals for many years, to the point where some countries are now making it a mandatory requirement for dogs".

"The programme will be rolled out initially in the UK, Germany and the Netherlands, our biggest challenge is to train and certify sufficient installers to implant the chips. Initially, it will be offered as an option alongside the Smart card, but we expect that within three years the uptake will exceed 50 percent".

NB: This article was published 1 April 2016 and was a so called "April Fools Day" joke.