
TheStandard
2019 Edition
35
PUSHING
BOUNDARIES
Celebrating 35 years in the motion capture industry
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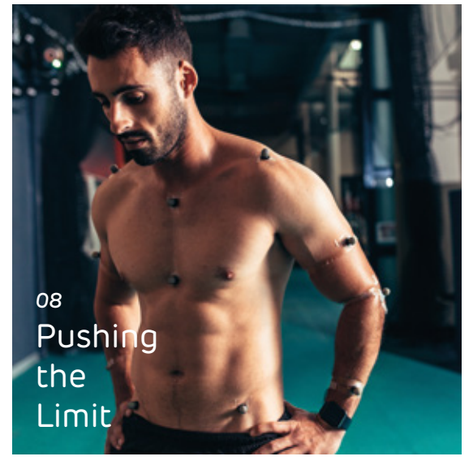
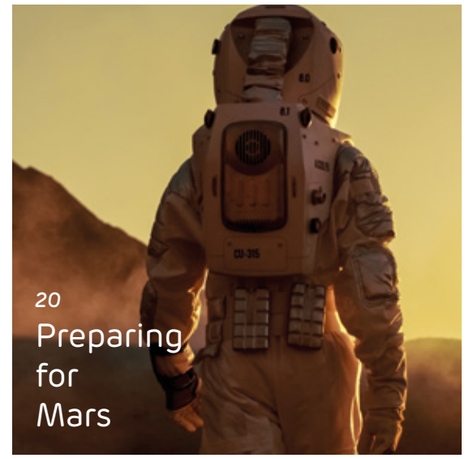
MEET THE TEAM





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PUSH-ING BOUND-ARIES

CELEBRATING 35 YEARS IN THE MOTION CAPTURE INDUSTRY

I would like to welcome you to this special 35th anniversary edition of The Standard!

In last year's Standard, I wrote about themes of expanding the multi-modal capture abilities within Vicon and the future need for greater accessibility, both commercially and technically for motion capture products. In this year's edition, I would like to shift the focus.

An area of particular interest to Vicon is the growing need for motion measurement products and technologies to work alongside the more traditional research-based motion capture and tracking. This emerging demand for motion measurement was one of the reasons that Vicon acquired IMeasureU, a wearable inertial technology business, in June 2017.

There are many different wearable technologies on the market. Our belief at Vicon and IMeasureU is that these devices, and the human movement measurements they provide, must be backed up by the necessary research to prove their efficacy. Therefore, we will continue to work with the scientific community to derive outcomes that are based on validated and published methods. Although this ultimately takes more time, our belief is that there must always be science behind our products.

We will continue to invest in the integration of inertial and optical technologies, working alongside our expert users in the field to ensure relevance, reliability and efficacy in the measures provided by the devices.

In combining optical and inertial technologies, we are still in the early stages of really understanding how these measures could and should work together. The demand for subjects to be able to leave the laboratory and continue to capture is obvious, but as the technology reaches wide-scale adoption, these types of multi modal products will be used differently to a camera tracking system. For example, the IMeasureU Step product uses only inertial sensors, an iPhone and an internet connection: a somewhat easier prospect than learning to use a 100-camera Vicon system!

The recent acceleration of the location based virtual reality (LBVR) market has been phenomenal. In 2018, we launched Origin, our first fully active tracking system, which is being used to power exciting VR experiences that are being rolled out around the globe. All of us at Vicon believe that VR will factor in across more of our traditional markets, including life sciences, and this is demonstrated by the work being done by groups like Durham University (which made for a very interesting article in this magazine)..

As we move further into the era of multi modal capture and tracking, we look forward to growing and maturing our offerings to allow our customers to use the best methods to get the best outcomes.

Finally, I would like to thank our growing community of Vicon and IMeasureU users for your support and feedback. The collaborative nature of our client relationships is fundamental to our success. We will continue to listen, be accessible and honest. Your passion drives our innovation.

Please enjoy our 35th Anniversary of the Vicon Standard and here's to another dynamic year in the world of motion capture!

Imogen Moorhouse
Vicon CEO

MAKING THE SPORT OF KINGS SAFER & FASTER

A RESEARCH PROJECT AT THE UNIVERSITY OF MELBOURNE IS TRYING TO UNDERSTAND WHAT A HORSE SKELETON CAN HANDLE IN ORDER TO HELP PREVENT INJURIES AND IMPROVE TRAINING

Australia's Melbourne Cup is the horse race that stops a nation. Every November, well over 110,000 racegoers descend upon Melbourne, Australia's Flemington race track to see one of the world's most famous sporting events. Millions of dollars are on the line, and the horses that compete are regarded with the same wonder and attention as a high-performance sports car.

Since 1861, the Melbourne Cup has seen top horses from around the globe compete for the largest prize purse in the southern hemisphere. With horses and riders lined up at the gate, they are 3,200 meters away from claiming the nearly $6 million payout and earning a place in history. But while the eyes of the racing world are affixed to the finish line, Professor Chris Whitton and his team from the University of Melbourne are focusing on each individual step along the way.

Although professional horse racing is a multi-million dollar industry, the act of taking care of horses and training them for the big races remains reliant on tradition as much as science. Breeding patterns can be traced back generations, but the long-term health of each animal remains mostly enigmatic. Catastrophic injuries can strike without warning, costing the horse's owners and team millions of dollars in potential winnings - and often ending the horse's racing career.

On the surface, it's similar to a practice some professional athletes are using to track their own movements for analysis, but it goes a step further.

To help understand the nature of injuries to race horses, Whitton - Head of the University's U-Vet Werribee Animal Hospital's Equine Centre and a specialist in equine surgery -- is leading a new research project to study and better understand a horse's skeletal loading. The hope is that with more information on how a horse moves and the stresses their bodies undergo while racing, new methods of training and possibly rehabilitation can lead to better results on the racetrack, as well as better lives for the horses. "We need to get much better at understanding catastrophic injuries because we currently can't repair these types of issues," said Whitton. "It's a real problem that needs to be solved."

Whitton and his team have been researching skeletal load for the past two years, but a recent partnership with Racing Victoria, along with additional funding from the Australian government, have created new possibilities. That led Whitton and his team to the Pakenham racetrack in Melbourne, where they were able to record horses at a full gallop on both sand and synthetic surfaces using several high-speed Vicon motion capture cameras, each capable of recording at 300 Hz.

On the surface, it's similar to a practice some professional athletes are using to track their own movements for analysis, but it goes a step further. Horses have been recorded inside arenas and on treadmills, but this marks the first time that motion capture cameras have been used under actual race conditions. Whitton and his team outfitted a 30-meter section of the Pakenham with cameras, then captured footage of three horses running at full gallop, each completing 5-6 full cycles. The team also used a track tester to measure the mechanical properties of the track.

The captured video was then analyzed shot-by-shot by biomechanical experts, who looked at the movement of the muscles, tendons and bones to help to understand the load on a horse's skeleton. Whitton and his team also examined horse bones in a laboratory setting, stress testing them to understand their limits. That data is being used to create mathematical models designed to help create a better understanding of how much stress can safely be put on a race horse, and how long they need to heal. That will, in turn, lead to better training regimens for horses, which could lead to better performances and longer careers.

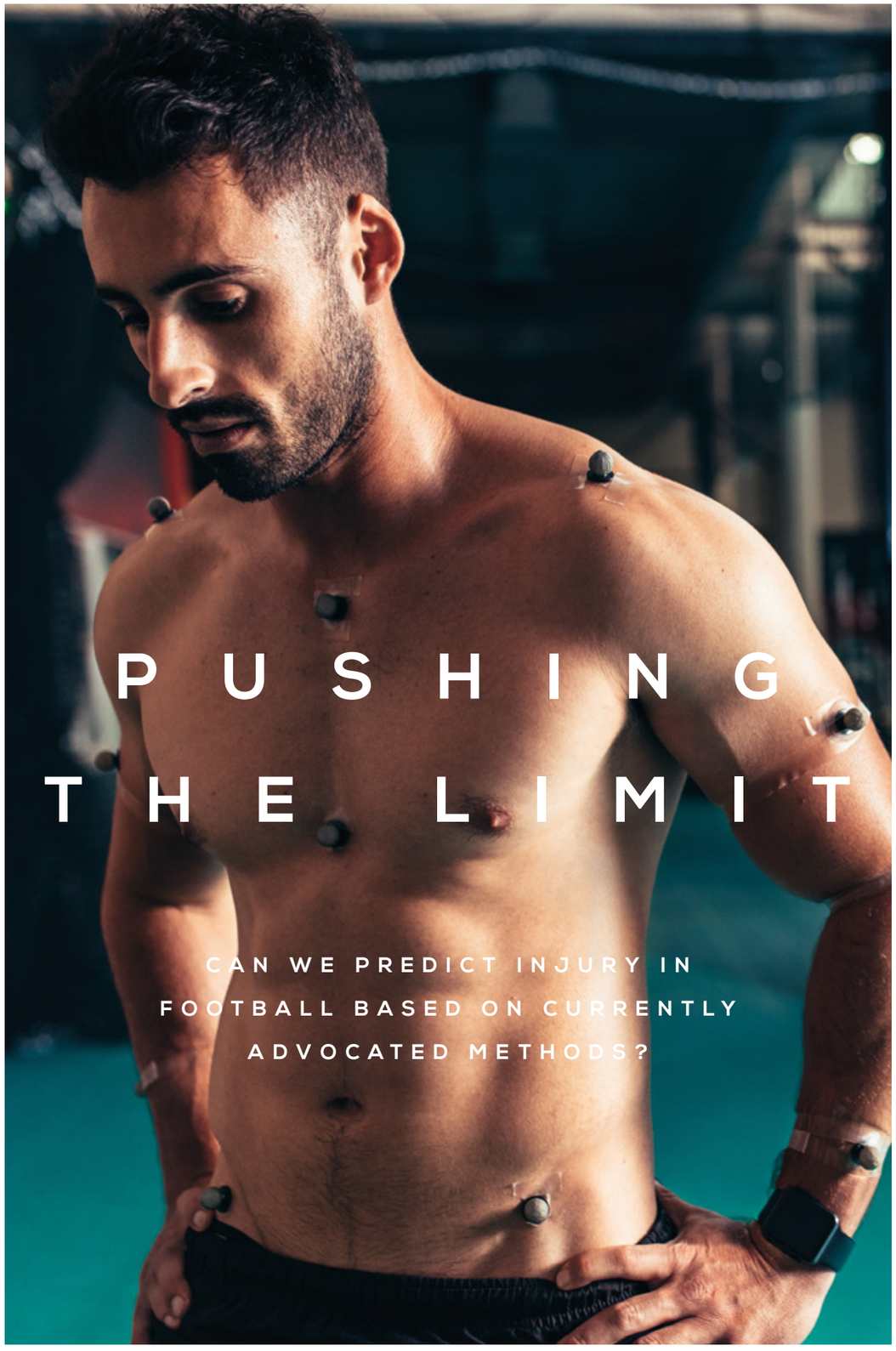
One of the more common injuries to a race horse occurs in a horse's fetlock joint, also known as the metacarpophalangeal (MCPJ) and metatarsophalangeal (MTPJ) joints. These joints are sometimes incorrectly considered a horse's ankle due to their location between the cannon leg bone that is equivalent to a human's tibia in location, and the smaller pastern bones that connect the hoof. A more accurate comparison would be a knuckle, akin to the ball of a foot.

During a gallop, a horse – which can weigh between 1,200 and 1,600 lbs - can reach speeds of up to 70 kph (roughly 43 mph). During movement at speed, its fetlock joint can reach a loading force of up to 4,000 kg, or roughly 40,000 N. To put this in context, that is the same force generated by four Volkswagen Golfs. These joints take damage over time, like all joints, but racing exacerbates it. They can heal and regenerate with rest, but avoiding the injury altogether can be the difference between a million dollar purse and the end of a racing career.

Bone is also capable of efficiently repairing itself and adapting to different load demands. However, it needs time to repair itself. Adequate rest periods between stressing the bone enhance bone replacement, but there has never been a consensus on how much rest is necessary, and it differs by horse. Part of the goal of Whitton's research is to help create a baseline that can be applied to each horse to find the ideal balance between training and rest.

The research is still ongoing, but Whitton and his team are in constant contact with race teams to create more scientifically proven training schedules. Whitton also released the initial results of the study at the International Conference on Equine Exercise Physiology (ICEEP) in Melbourne, but the project is far from complete.

The next step for the researchers is to record horses at full gallop on more complex surfaces, including turf. That will further inform the algorithms and improve the predictive model.



The project was not without its challenges, as the requirements of the FMS pushed the capabilities of the participants and the model to their limits

DR FRASER PHILP
Lecturer in Physiotherapy and Rehabilitation and Exercise Science at Keele University

Football (or soccer in the United States) is one of the world's favorite pastimes, regardless of whether people are watching or playing it. As football continues to grow on the international stage, there is an increasing demand on footballers to push the limits of performance and remain injury free. Sports and exercise medical practitioners are therefore tasked with trying to reduce the risk of injury for individual players and mitigate the impact of overall injury rates on team performance.

At Keele University, we have examined a commonly used, clinical decision-making tool, testing its ability to measure performance of human movement and predict injury. Knowing the performance characteristics of such clinical assessments could help improve decision-making processes and reduce the burden of injury in football.

Of the many screening tests available within football, the Functional Movement Screen (FMS) is most commonly used for predicting injury. Use of the FMS is not exclusive to football: other sports clubs/authorities (e.g., NFL, NBA and NHL), public services (e.g., firefighters) and the armed services use this method of screening. The FMS requires participants to perform a series of movements, including a squat, lunge, press-up and test of shoulder mobility, for which they are scored by an assessor. The assessor awards a score based on real-time visual observation only, tracking a number of movements at different joints simultaneously to decide the score. Lower scores are assumed to be indicative of a higher injury risk due to poor movement patterns. Although the FMS is commonly used, its validity and reliability have not been objectively evaluated.

Capturing movement performance indicators in athletes performing complex 3D movements is no easy task. Therefore, to ensure we accurately captured the footballers' performance, we used the Vicon motion capture system based in our laboratory at Keele University. The preseason FMS scores for 24 individual players from the men's football team were simultaneously assessed by a certified FMS assessor and calculated using the Vicon motion analysis system and the Plug-in Gait full body marker set with additional pelvis and thorax markers to compensate for marker occlusion (full details of the study and thesis can be found hereand hererespectively). We then followed the footballers throughout one competitive season in a University league documenting injury patterns. From the data we were able to

1. Evaluate the performance of the FMS scoring structure and all its rules
2. Determine an FMS reference score based on the 3D analysis of the actual movement and compare it against the score allocated by the assessor
3. Check whether either the real-time assessor or 3D reference scores could predict injury

The project was not without its challenges, as the requirements of the FMS pushed the capabilities of the participants and the model to their limits, with things such as gimbal lock in the upper limb being the proverbial fly in the ointment.

The Vicon system was extremely useful for evaluation of the FMS and allowed us to highlight the complexity of the FMS scoring process and its failure to behave as a measurement scale. We were also able to determine thatneither scoring process was able to predict serious injury in footballers and concluded that sports practitioners may want to reconsider using the FMS. As our research progresses we are looking to identify if there are other movement characteristics outside of the FMS framework which could help identify injury mechanisms and continue to explore how we can improve performance measures to help sports practitioners with decision making processes.

5 MINUTE INTERVIEW

DR KIM DUFFY
Vicon's Life Sciences Product Manager

Doctor Kim Duffy joined Vicon in 2017, and last year assumed the role of life sciences product manager. Building on her years of academic research and innovation, her focus is on the introduction and growth of Vicon's products, as they relate to fields ranging from healthcare to physical training to injury recovery and more.

Where did you grow up?
I grew up in Sheffield (South Yorkshire), which is in the north of England.
At 18, I moved to Liverpool, and since then I've lived in various cities in the south of England. Despite moving around I still have my Yorkshire accent, something I am very proud of!

Where did your interest in biomechanics and motion capture start?
My interest in biomechanics started at quite a young age. During my teen years I was (and still am) football mad. I played for Sheffield Wednesday Ladies FC, but unfortunately I received a nasty tackle which resulted in my left ACL snapping. I had knee surgery and a lot of rehab! Luckily, I did play again.

That whole experience gave me a fascination with biomechanics, and especially with injury prevention and rehabilitation. This was one of the reasons I chose to study sports science,earning a bachelors of science with honours at Liverpool John Moores University. I was introduced to motion capture and my interest in sports biomechanics and gait analysis grew!

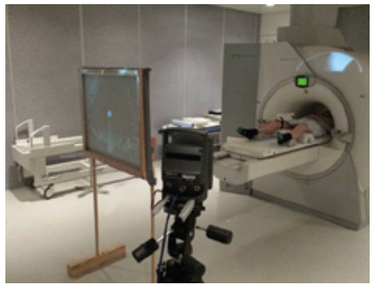
What did you do before Vicon?
After my bachelors, I continued at Liverpool John Moores University to undertake a masters in biomechanics of gait and posture. I collaborated with Prof. Tom Shannon, co-founder of Vicon Motion Systems, on my research project. With the assistance of my supervisor Prof. Gabor Barton, we designed a protocol to determine the feasibility of using motion capture systems to act as the "controller" for a virtual game, whilst having a fMRI scan. It was a challenging, but rewarding project, and still one of my favorite research projects to date! I then moved to University of Essex to continue researching for my PhD, which focused on using a Vicon motion capture system to explore the effects of age on gait and functional movement characteristics in older adult populations. Working at Liverpool John Moores University and University of Essex showed me how technology and research come together to open new possibilities and illustrated the impact motion capture can have on a patient's rehabilitation.

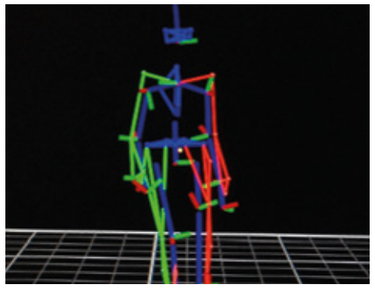
When did you join Vicon?
April 2017. I started as a support engineer and also completed my PhD during this time. I became the life sciences product manager in May of 2018.

Favorite thing about working for Vicon?
The people! Vicon is very much a big family.

Where do you see Vicon in 5-10 years' time?
Everywhere! I think motion capture will become the norm for life sciences. We are using more and more technology to assist motion monitoring for athletes and clinical interpretation, and I see this only growing in popularity. I also think we are going to see more motion capture outside gait laboratories.

At 18, I moved to Liverpool, and since then I've lived in various cities in the south of England. Despite moving around I still have my Yorkshire accent, something I am very proud of!





Q&A: V1 INTERACTIVE'S MARCUS LEHTO TALKS QUALITY OVER QUANTITY

Game developer V1 Interactive's President and Creative Director discusses how technology and experience have made it possible for a small studio to compete.

Game developer V1 Interactive's president and creative director Marcus Lehto discusses how technology and experience have made it possible for a small studio to compete.

Headquartered in the Seattle metro, an area that is home to some of the oldest and most famous game development studios in the world, V1 Interactive is relatively small by comparison. With a staff of around 30, it's a fraction of the size of some of its peers, and it will soon be stepping into a very competitive field dominated by big budgets and long-running franchises.

But what V1 Interactive lacks in size it makes up for in experience. Each team member was specifically recruited for their job and comes with years -- in some cases decades -- of experience. Each step in the process has been finely honed using cutting-edge technology in the hands of people that know exactly how to use it, and at the heart, the developers have a shared goal: making something fun.

With the reveal of its first title due in early 2019, we spoke to V1 Interactive's founder and creative director Marcus Lehto about assembling a team, using technology like motion capture to balance the scales and getting back to his roots.

How did the idea for V1 Interactive come about?
After developing games for over two decades and helping build major franchises like "Myth," co-creating the Halo universe -- now over a 5 billion dollar industry -- and kicking off "Destiny" (along with helping Bungie grow from a small studio to the giant it is today), I decided that Iwanted to get back to the root of what makes creating games so rewarding -- a small team of dedicated professionals, all of whom are hands-on making something fun together.

It all started with a core idea I had. With the help of a few dedicated students willing to take a leap with me and build a prototype, we pitched it around and landed a great publishing relationship with Private Division, part of Take Two Interactive. After we landed the publishing deal, the studio quickly took off and grew rapidly.

Who are the founders and main people behind V1 Interactive?
While the owners of V1 are myself and my business partner, Mike Gutmann (previously from Zipper), the people at our studio all play a huge role in developing what we're making together. I had the pleasure of hiring back several people who I had worked with for many years while at Bungie, so a significant number of our devs are from the original crew that made "Halo."

What makes V1 different from other game studios?
I set out with the explicit goal of creating a studio capable of building smaller form factor games that are more affordable to make, but with a quality level that could stand toe-to-toe with any major studio.

The biggest difference is the experience we have in making high quality AAA games within the studio. We're in an era now where game developers have matured and fully understand the very complex production and constant evolution of making games.

In creating the studio, how important is cutting edge technology?
Very important! As a small studio our efficiency as developers is key, so finding the right tech to get the job done right was very important to us.

Why choose mocap over traditional animation or another form of performance capture?
With only two animators and one tech artist for the animation team, we needed to find ways to achieve large volumes of high-quality animation that suits the animation direction of our project quickly, with lots of iteration potential. There is still a lot of hand-keying that goes into our animation, but utilizing a mocap system like Vicon's helps us get 60-70 percent of the way there. Motion capture is a great tool in the animator's tool belt.

One thing that we didn't anticipate was how useful it's been to use mocap as a pre-visualization tool for our cinematics. The high fidelity mocap we get from the Vicon Vero cameras allows us to implement rough performances quickly for iteration. Our cinematic lead can then easily shoot around these performances using UE4's sequencer tools. Because the setup process to capture is very easy, we can experiment with acting choices without pressure, and have video reference to boot using the Vue's video overlay. Being able to have that flexibility for changes and experimentation is key to us.

How has motion capture influenced game development?
It has expedited the creation of assets for our gameplay and cinematics, especially. It offloads some of the more tedious, but much needed animation assets for a character so we can spend more time on assets that require fine-tuned hand-keying. It also helps set up the framework for cinematics and allows us to work back and forth with cinematics in an organic fashion.

What was your past experience with mocap?
At Bungie, we started utilizing mocap during the production of "Halo 2" and used it from then on in every game we developed. With every successive game, mocap became a core component of animation technology.

As a small studio with a limited budget, we shopped around for several options and were very excited when we found that Vicon had a newer, affordable solution aimed specifically at studios like us. The other solutions we had been looking into were similar in price but didn't offer the rich features we get with such an industry standard as Vicon, so it was an easy choice for us.

Our current setup includes 12 Vero 2.2 cameras, one Vue camera and Vicon's Shogun software suite (Live and Post). Vicon has been a good partner to us.

What's next for V1 Interactive?
We're hard at work developing and anxiously awaiting the release of our first game, which we're excited to share a lot of information about this year. Our hope is that we can continue building upon this new franchise we are creating while keeping our studio size reasonably small.

GOING THE DISTANCE

AFTER JOINING THE VICON FAMILY IN 2017, IMEASUREU HAS SEEN SIGNIFICANT EXPANSION, INCLUDING KEY HIRES AND RECORD SALES

With record sales across all three of our core lines of business (field-based biomechanics research, lower limb load monitoring and inertial sensor analytics services) we are now firmly embedded in the Vicon motion capture eco-system across the UK, Europe, Americas and Asia-Pacific.

A key highlight in 2018 was the commercial release of our unique lower limb load monitoring system, IMU Step, which is being used by world class athletes, teams, clinics and institutions around the world. We also welcomed new members around the globe, including Blake Whitcomb, our inaugural US-based business development manager, who joined us in 2017. James Grant joined us in September to take over our IMU customer success team.

Whitcomb had this to say about launching IMU Step in the United States:

I was fortunate this year to introduce many North American-based sport scientists, physical therapists, strength and conditioning coaches, biomechanists and athletic trainers to our innovative return-to-play and workload management tool for athletes.

We quickly generated customer interest via trials, enhancing our novel technology with valuable early adopter feedback contributing to product development. Ultimately, this led to our first IMU Step customers in the U.S.

MATT CLARKE
IMeasureU Director of Business Development

> I am immensely proud of the caliber of people who joined our U.S. team in 2018, and we will soon welcome our first UK-based sports scientist to better serve customers and support our growth in that region.

Opposite: Markevion Quinn, University of Memphis Quarterback, used IMU Step to return to running and helped his team win the AAC West Division
Below: Holly Lawrence, 2016 World 1/2 Ironman Champion, safely and successfully returned to running with IMU Step to defend her title and win the 2018 1/2 Ironman Middle East Championship

Our early customers include NBA teams, orthopedic clinics, high performance national and state institutes of sport as well as several collegiate athletic & kinesiology departments. With practitioners now able to quantify lower extremity load in the real-world scenarios of their sport, we have seen a direct influence on the decisions made to optimize athletes' return to play after an injury.

We have also expanded our reach into a larger category of sports, including basketball, tennis, soccer, football, cricket, cross-country running and Australian rules football. As we head into 2019, we are excited about the upcoming product developments in the IMeasureU pipeline, and our expanding catalog of customer stories throughout a larger spectrum of sports and competitive levels.

It's exciting to see the U.S. market beginning to move beyond using GPS for load monitoring. Coaches better understand the value of measuring the load of limbs relative to each other, as opposed to treating the body as a single unit of mass. Humans are not cars!

As a former athlete and strength and conditioning coach who has lived the life of an athlete and worked as a high school, college and pro S&C, I feel tremendously privileged to be able to share IMU Step with coaches who work tirelessly to help their athletes safely and successfully return from injury.

My personal highlight this year was working with skilled pros like the University of Memphis' Max Paquette, Daniel Greenwood and Larry Reynolds, who used IMU Step to help bring back star Quarterback Markevion Quinn following an ACL injury. For me, this is real world validation that what we do here at IMeasureU matters.

Along with Blake, we continued to expand our presence by bringing new talent into key roles, including positions dedicated to highlighting our customers' successes. We welcomed James Grant into our Denver office in the fall, and he had this to say about his time so far:

What really excited me about the IMeasureU team was the passion and excitement I saw on both sides of the product.

Our staff is dedicated to building the best product possible, both in terms of user experience and scientific accuracy, while our customers are often even more excited about our potential. They are constantly finding new and interesting ways we can apply the insights from our data, and at IMeasureU this customer feedback is essential to our development process. It has been very rewarding to see features we work through with customers get integrated into our offering so quickly.

I have spent most of my career in the world of athlete wearables and sports medicine, and IMeasureU gives me the opportunity to leverage my experience into products that directly affect athlete and patient wellbeing. At the end of the day, providing data that can help someone recover from an injury, or even possibly stop one from occurring in the first place, gives us a rewarding goal to strive for.

IMeasureU's integration with Vicon has allowed me to work in a startup environment with the backing and infrastructure of a company that is firmly established and respected. We have a small, focused team at IMU, and the support of Vicon allows us to completely focus on creating the best products possible for our customers. It really has been the best of both worlds.

I am looking forward to seeing what 2019 brings for IMeasureU!

I am immensely proud of the caliber of people who joined our U.S. team in 2018 and I'm excited to welcome Dan Savin as our first ever UK-based sports scientist. Dan joins us in February 2019 and will be based in our Oxford office to better serve customers and support our growth in the UK and Europe.

For me, the ultimate measure of our people, products and services is reflected in the quality of our customers. Given some of the world's best coaches, athletes and practitioners are already working with us, 2019 promises to be another massive year of growth for IMeasureU. I'm particularly excited about the imminent launch of our next generation inertial sensor that will change the game for researchers and practitioners alike.

"Vicon offers cutting edge technology that does exactly what we need it to do out of the box. When we saw the capabilities of Origin, it opened up a whole new world of possibilities."

Sander Bos, VR Arcade CEO

ORIGIN IS BORN

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VIPER

Explore new realities. Define a new era in motion tracking.

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Each participant is identified and tracked with Origin's fully customizable cluster tracking.

Compact
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Tracking LED
AutoHeal technology for unbreakable tracking.

PULSAR

Scalable volume tracking. High performing LED markers create fully immersive experiences.

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Clusters can be attached to each participant effortlessly.

Adaptive patterns
Pulsar's adaptive patterns make any project possible.

Lightweight
Unique, lightweight body and mounted tracking sensors.

BEACON

Packed with power. Create a synchronized, seamless wireless network.

RF Sync
Creating a wireless network for seamless connectivity with all devices.

Device sync
Syncs with Vicon and third party devices.

Plug & play
Making LBVR accessible to all with simple plug and play technology.

EVOKE

Create your own reality. Intelligent software designed for Location Based VR environments.

Unbreakable tracking
For a totally immersive and seamless experience.

Characters from clusters
Unlimited full body movement tracking creates recognizable characters.

System AutoHeal
Evoke automatically repairs camera calibration with active data to reduce intervention.

Mark Finch is an inventor, with a Masters in Biomedical Engineering from the University of Auckland. Mark has spent the last 6 years developing the core technology of IMeasureU, based at the Auckland Bioengineering Institute, before assuming the position of new Chief Technology Officer here at Vicon.

THE JOURNEY

FROM IMEASUREU TO VICON: MARK FINCH'S JOURNEY TO CTO

MARK FINCH
Vicon's new Chief Technology Officer

Above: Vicon Blue Thunder is a small, lightweight IMU (only 12 g) containing three sensors, capturing 9-axis of measurement.
Opposite Top: Thor, Andy and I at the NZ innovation awards, where we won the award for "Innovation in Information Communications Technology and Cloud Solutions".
Opposite Bottom: Thor, Sonia (Thors wife), Liv (my wife) and me at the New Zealander of the year awards – Thor and I were selected as semi-finalists for New Zealander of the year in the innovation category.

Throughout my teenage years, I was very focused on competitive swimming at a national level, ultimately receiving a national ranking in New Zealand in my event. Then when I was 18, I was in a car accident that ended my swimming career. It was a turning point for my priorities and my outlook on life. It gave me the fuel for my future career, and helped establish my focus on developing technology to help others.

After I recovered from the accident, I began my studies at the University of Auckland, completing both an undergraduate and masters degree in biomedical engineering. My masters thesis title was "Unobtrusive Wireless EMG Coupled with Three Axis Accelerometer," which included a wireless chipset I developed that included a miniaturized mems 3-axis accelerometer with EMG. The end goal was to enable users to quantify both the muscle activation and dynamic body movement caused by the muscle activations.

This was the first step in a career that has been built around inertial measurements and body motion, specifically focused on leveraging the technology into the real world. After my masters, I worked at the University of Auckland for a number of years as a research engineer, further developing my expertise with inertial measurements, researching various fields ranging from quantifying body movement to utilizing the inertial technology to better understanding "shaken baby syndrome" in infants.

Throughout my research career I'd always had the ambition of starting my own company. That was further enhanced when I was fortunate enough to win a scholarship to attend the "Stanford University Summer Institute for Entrepreneurship" -- essentially a crash course in entrepreneurship.

In 2013, Thor Besier and I founded IMeasureU. Over the next four years we built it up, and in 2017 we became part of Vicon. Thor and I developed the technological vision for IMeasureU early on, which involved coupling inertial measurement units (IMU) with biomechanics and computational models to deliver end-to-end solutions around body motion. The team that we built up, and the progression of products that the team were able to build and deliver were a perfect fit with Vicon, which is ultimately what drove the successful acquisition.

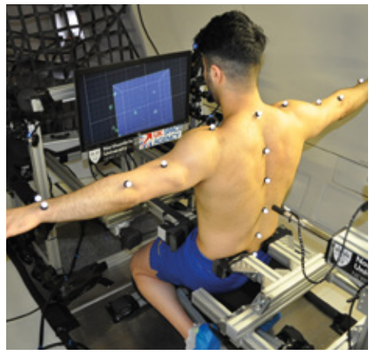
The past 18 months have been focused on delivering products, but also planning and leveraging the technology into the Vicon product line. Becoming a part of the Vicon family has given me insight into working within a larger international group, as Vicon has development teams spreading across three continents! My work with IMU, bridging into Vicon, has given me a distinct set of skills - not only technical, but also market knowledge and an understanding of customer needs and affinity for technology.

My background and passion for technology, combined with my experience working interchangeably with IMUs and motion capture, puts me in a unique position, setting the foundation for me to step into the role of Vicon's new Chief Technogical Officer (CTO).

The next step in my journey is a relocation from Auckland to the Vicon HQ in Oxford. I will help drive the team to ensure we future-proof our market position as world leaders in all things motion capture, as well as explore new technologies and markets. We want to push the capabilities of where and how those technologies can be leveraged for the greater good.

PREPARING FOR MARS, STARTING WITH THE SPINE

RESEARCHERS AT NORTHUMBRIA UNIVERSITY ARE STUDYING SPINAL CONDITIONS IN LOW GRAVITY TO CREATE EXERCISES FOR ASTRONAUTS THAT WILL TAKE EXTENDED SPACE FLIGHTS



While joints and muscles can all be affected by the absence of gravity, a major concern for astronauts who spend time in space is the spine.

If current predictions hold, at some point in the next 20 years humans will walk on Mars. It will be a defining moment for the human race, but before we can explore our nearest neighboring planet there are several problems we have yet to solve – including how to stay healthy during extended periods away from Earth's gravity.

While joints and muscles can all be affected by the absence of gravity, a major concern for astronauts who spend time in space is the spine. When you factor in the possibility of humans spending months in low gravity -- followed by heavy exertion under the gravity of Mars and then another lengthy period of time spent on low gravity on the lengthy return trip -- those spinal issues go from worrying to mission critical. To help prepare future astronauts, Northumbria University's Aerospace Medicine and Rehabilitation Laboratory, in association with the European Space Agency (ESA), is working on creating a new set of exercises for astronauts to engage with under zero-G.

The current record holder for the longest consecutive time spent in space is Russian cosmonaut Valeri Polyakov, who spent 438 days on Russia's Mir Space Station in 1994-95. Although he eventually made a full recovery after returning to Earth, his time in space showed that without gravity the body begins to experience the same effects found in the elderly, including both bone density loss and muscular deterioration. This is especially pronounced in the spine, and many astronauts have reported severe lower back pains following their time in space.

Astronauts on the International Space Station currently spend 2.5 hours per day following a strict workout schedule, but most still need to undergo rigorous physical therapy when they return to Earth. Fortunately for the astronauts, following their return to Earth's 1G environment, astronauts are not expected to engage in strenuous activity. A trip to Mars could take months, and when they arrive, the first humans on Mars will need to land and work under its 0.38 gravity. That's obviously significantly less taxing than the gravity on Earth, but the shift from zero-G to any gravity could provoke serious issues.

Space agencies around the world are also preparing for a return to the moon, which may eventually lead to a semi-permanent presence on the lunar surface, or at least frequent trips between the moon and an orbital station. Even though the lunar gravity is just 0.16G, the change between gravity conditions could also cause physical issues if not addressed.

With the moon and Mars both targeted for human visitation, ESA began accepting bids for research projects to study the effects of reduced gravity on the body. Northumbria's proposal to look at how reduced gravity affects spinal postural control was selected over several others, and in June 2018 it began tests.

In order to design exercises for a low-gravity or gravity-free environment, those conditions must be sim ulated and data must be recorded from multiple angles. It also requires working on a unique type of plane that is affectionately known as the "vomit comet."

To begin, the research team from Northumbria, led by Professor Nick Caplan, secured the services of a plane capable of parabolic flight. The exact model has changed over the years, but the concept remains the same – a plane large enough to house multiple people climbs rapidly, and when it reaches a nose up angle of about 45 degrees, the engines are cut and the plane enters a freefall state as it flies over the top of a parabolic curve. When the plane reaches a nose down angle of about 45 degrees, the engines switch back on and the pilots pull the plane out of its dive. While the plane completes the parabolic arc, the passengers are essentially in freefall, which in a contained environment can be used to simulate zero-G. Each weightless period lasts no more than 25 seconds, so a typical parabolic flight repeats the maneuver between 40-60 times, with 65 seconds spent climbing followed by under 30 seconds falling.

With the conditions established, Northumbria still needed to create a practical means to record participants under zero-G which meant using specialized equipment, including 14 Vicon Vertex optical motion capture cameras. The high-speed equipment was capable of withstanding the violent shifts in the parabolic flight while capturing precise -- and often unpredictable -- movements of its subjects. The team also created a bespoke rig to hold everything in place.

Northumbria used a Delsys Trigno system for the assessment of spinal muscle activity using fine-wire electrodes, with the data streaming live into Vicon's Nexus software. The tests were so demanding and thorough, not to mention unique, that Northumbria's feedback actually helped Vicon create future updates for the software.

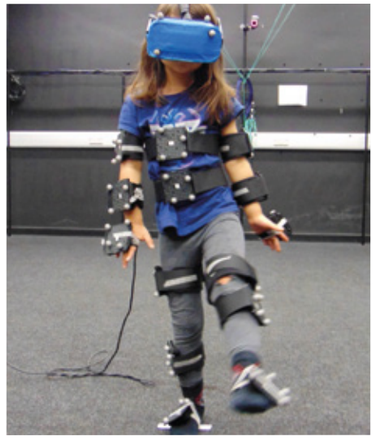
To measure the gravity levels during each parabolic maneuver, Northumbria also used three IMeasureU inertial sensors attached to the custom rack in order to monitor and detect the target levels of gravity.

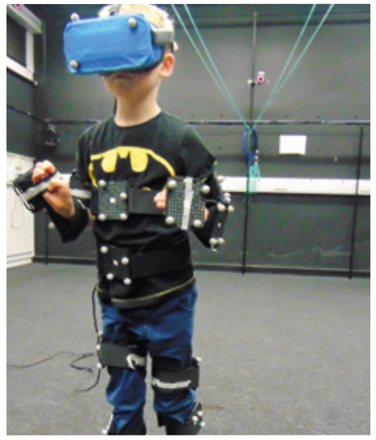
While the goal of this particular test was to help astronauts while in space, it is also a part of a bigger research program focused on maintaining the health of the spinal muscles that contribute to posture control. Lower back problems are becoming an increasingly common complaint, and spinal muscular deterioration is caused by a host of factors beyond aging, including a sedentary lifestyle. This form of research is meant to help that group as well.

During its time on the vomit comet, Northumbria collected a huge amount of data that the team -- now firmly back on the ground -- is currently analyzing. The researchers will use the data to create a series of exercises specifically designed to help strengthen and maintain spinal muscles in partial gravity, although the results may have a larger impact on spinal conditioning for those of us trapped under Earth's 1G.

REDEFINING THE MEANING OF 'SELF' IN A VIRTUAL FUTURE

A STUDY CONDUCTED AT ENGLAND'S DURHAM UNIVERSITY USES MULTISENSORY INTEGRATION TO DETERMINE HOW CHILDREN RECOGNIZE THEIR OWN BODIES IN VR





The technology powering virtual reality is still in its infancy, and as such people are still learning how best to embrace it. The entertainment industry has been the largest driving force behind its growth, but other industries are using VR to great effect; from architecture to healthcare to shopping. While the goals of the developers may vary, how we react within a VR environment generally remains consistent across industries. What if our self-image is variable based on factors like age? What if our concept of "self" changes as we age?

A new study conducted at Durham University's Psychology Department is using a combination of custom-built virtual reality environments and motion capture cameras to study how subjects of different ages view themselves in a virtual environment - and the results are remarkable. In test after test conducted with subjects of all ages, children have shown a far greater sense of ownership over their virtual bodies than their adult counterparts.

"We were surprised with the extent to which children accept a body that is moving completely randomly," said Sam Keenaghan, Ph.D student. "It really shows how flexible children's bodily awareness is as they attempt to keep track of a body that is constantly changing and growing."

While this understanding will help VR development in multiple fields (including entertainment), it also led the research team behind the test to reach a preliminary conclusion that children - specifically 5-year-olds - do not necessarily rely on physical movement to establish an identity of self in the same way that adults do. That suggests that the current theories of human spatial development are inadequate, which may lead to a better understanding of how we perceive ourselves in a virtual environment.

Durham University's Psychology Department recruited both adults and 5-year-olds for the experiment. The participants then stepped into Durham's lab, equipped with 16 Vicon Bonita cameras and Vicon Tracker software that allowed the team to precisely track participants' movements, regardless of their age or size.

The team also leaned heavily on Vicon's Pegasus software, a retargeting solution typically used by video game developers to map mocap data onto virtual avatars. Pegasus allowed the Durham crew to apply participants' movements to their virtual selves in real time, and to easily manipulate variables such as virtual body size and perspective.

The children and adults were then shown first-person perspective views of their virtual bodies, with different subjects controlling avatars of different sizes; some found themselves in smaller bodies than their own, some were in bodies roughly the same size, and some were in bodies that were much larger. Some of the participants saw their real-world movements precisely mimicked in the virtual world thanks to the precision mocap cameras, while some avatars moved randomly, with no relation to the movements of the participant.

While in both age groups the size made no difference to the way the participants viewed their virtual bodies, the older group had trouble connecting to avatars that moved randomly. The younger group were able to connect to their virtual bodies despite variations in both size and movement. Virtual reality hinges on the user's perception of their own movements in relation to what they're seeing displayed in the headset. If children perceive that relationship differently from adults, knowing how and why could be vital to developing VR software for young audiences.

The results of the virtual body movement tests are one part of a larger body of research being conducted by Durham University. Earlier tests focused on the spatial memory of children, including an experiment where they were equipped with wands that they used to identify target objects in a virtual environment. Through deliberate design, the team "teleported" the kids within the VR environment to different locations, then asked them to use landmarks to identify the same targets, which were now hidden by obstacles. The results suggested that children's ability to remember spatial information did not differ whether 3D landmarks or 2D landmarks were used.

Translating real-time movements into virtual spaces is no simple task for the most accommodating participants, but when the subjects are small and easily distracted, it becomes more difficult. To help track the movements of children with the precision needed for a study like this, Durham again turned to Vicon.

For the last five years, Durham has relied on Vicon's optical systems for its motion tracking needs, but adding in children presented an extra challenge. Existing mocap gear is not scaled for five-year-olds, so the university worked with Vicon to develop child-sized straps and plates.

"We used Vicon's mocap system with children to examine the development of bodily awareness in childhood in ways that haven't been done before," said Keenaghan. "The precision and reliability of the Vicon system we use is key to making this ground-breaking research possible."

The success of its experiments has spurred the Durham team to continue working with children in similar capacities - as did the enthusiasm of the young participants, who love to "dress up like robots" when they wear motion capture trackers. The children don't follow directions quite as well as their adult counterparts, but they tend to be more engaged in the tests and enjoy experimenting with their "cartoon bodies." Many of the young participants are repeat subjects, and they eagerly await the next tests.

"Working with children can certainly be more challenging than working with adults, but it is definitely more fun and rewarding," said Keenaghan. "Plus, witnessing their excitement when they put the headset on for the first time and see the environment we have created for them is a joy."

The Durham University Psychological Department continues to gather data on spatial awareness in virtual reality for both children and adults. The implications could reach across multiple fields and help lead to better VR development.

Adopting Origin, Vicon's Location-Based Virtual Reality System, VR Arcade is Redefining What it Means to go to the Arcade.

VR ARCADE

KEEPING THE SPIRIT OF THE COIN-OP ARCADE ALIVE THROUGH VR

For a child of the 1980s, spending time at the local arcade was a rite of passage. Quarters were fuel for the machine, and no couch cushion was safe from a thorough search for loose change. It was a multi-billion dollar industry and even a lifestyle for many, and remained a dominant force in entertainment until home gaming stole its thunder.

While arcades will probably never return to their glorious heights from the '80s, they continue to find new ways to survive – and even thrive. "Barcades" have popped up around the world, attracting adults by appealing to their love of bars and nostalgia, but another more traditional form of arcade is finding a renaissance thanks to the rise of virtual reality.

Around the world, developers are looking to bring VR to the crowds, often creating VR experiences similar to those that home users shelling out for top-of-the-line equipment are using. But a few developers are going one step further and mixing those experiences with a real-world component. Rather than just putting on a headset and remaining in a contained area, players can experiment with location-based VR (LBVR), where they are able to freely roam around what looks like an empty area to observers – but to the player appears to be a true, open virtual world to explore.

The practice of incorporating LBVR into a virtual arcade is beginning to catch on around the world, and one of the pioneers in this form of gaming is VR Arcade, a young company located in the Netherlands. By combining technical expertise, game development skill, and general business acumen, the Dutch startup is hoping to expand throughout Europe with the help of Origin by Vicon, a system created specifically for LBVR.

VR Arcade began in 2016 when game developer Wilco Vos and his friend, professional piano player Sander Bos, had a minor epiphany. They were both impressed by the potential of consumer-level virtual reality, but felt that the physical limitations caused by cords and limited tracking abilities were preventing the technology from truly offering an immersive experience. With the help of their friend, professional golfer Sebastiann de Jonge, they decided to do something about it. In October 2016, the first VR Arcade opened its doors in Amsterdam.

The idea is simple enough, even if the execution is anything but. VR Arcade accommodates teams of up to five at a time, and following a brief tutorial and a few minutes playing VR mini games (in order to introduce VR to any newcomers), they are ushered into a large, 240-square-foot empty space. There they put on a battery backpack and an Oculus headset and take possession of a plastic rifle that acts as a peripheral in the game. From there, they are transported into a different world.

VR Arcade currently offers two games – Zombie Apocalypse and Alien Defense – both of which were created in-house by Vos and a team of developers using Unity, 3ds Max and Substance Painter. The environments and gameplay differ in each game, but the goal is essentially the same: work with your team, keep moving to stay alive and shoot the monsters that stand in your way. After the 20-minute session, teams (of legal age) can relax and enjoy a drink at VR Arcade's bar.

To create their first fully immersive and free-roaming VR world, VR Arcade created a bespoke LBVR system featuring 39 motion capture cameras and software. Each player is fitted with one active tracker on their headset and another on their peripheral that record their movements in order to send data into the game. Players are able to see their own head and weapon movements reflected, as well as those of their teammates.

The solution continues to be used in VR Arcade's original location, but the costs and the complexity of the technology – which often requires the system to be manually adjusted between uses – made plans for expansion tricky. Then, in August 2018, Vicon released a solution designed with virtual arcades (and similar LBVR locations) in mind.

At SIGGRAPH 2018, Vicon announced and released Origin, its LBVR system which offers a ready-to-use solution. The system featured everything VR Arcade needed to create a new VR arena. Installation was straightforward and the software took care of the rest, including automatically correcting and healing itself between user sessions. Origin not only cut the costs, but made it easier for VR Arcade staff to use and maintain. It also uses multiple trackers, expanding the number of physical movements reflected in the game.

With a new solution in hand, the VR Arcade team began to focus on expansion. In November 2018, the team opened its second location in Delft, Netherlands, with two playing fields covering 19-by-12.5 meters. With bookings starting to come in before the second location even opened, a third location measuring 17-by-17 meters located in Helmond was recently commissioned in December 2018. A fourth location is being planned for spring 2019, and expansion beyond the Netherlands and throughout Europe is being considered.

"We are now busy with expanding in the Netherlands," said Bos. "Our first phase was to build three locations in 2018 (the first being the Delfgauw location). Then our path will take two different roads: one concentrates on the expansion in the Netherlands, while the second will start with expansion in Germany."

While the days of dropping coins in slots and waiting for digital screens to fire up may be a thing of the past, their spirit is alive and well – and taking us places we never dreamed.

UNDERSTANDING THE MOVEMENTS, GESTURES & SKILLS INVOLVED IN CONDUCTING

University of Southampton researchers are creating a catalog of movements to help study the art of conducting.

It begins with a single motion. A quick flick of a baton and the silence is broken. Another movement and the tempo picks up, then another and new sounds join. It is an auditory explosion generated by dozens of individuals acting together, all working to create something that can inspire the imagination. And at the head of it all is a single figure exerting their will on the music through a series of movements, demanding the attention of both the musicians and the audience alike.

The act of conducting an orchestra is an art, with each practitioner finding their own approach and developing their own idiosyncrasies. Some exert a calming influence, accentuating the tempo with a delicate touch, while others attack with a gusto that emphasizes the power of the instruments. The best conductors are in demand around the world, and often receive top billing and salaries to match. Countless musicians aspire to wield the baton, yet many are left disappointed by the lack of resources available to help them achieve their goals. A new study on the nature of conducting hopes to gain a greater understanding of the artform, potentially leading to new ways for conductors to train.

Located in southern England, the University of Southampton is working on a project known as "Capturing the Contemporary Conductor," led by Drs. Richard Polfreman, Cheryl Metcalf and Ben Oliver. Using high-speed motion capture cameras, the study aims to record and collect the movements of conductors down to the slightest twitch.

With funding courtesy of the British Academy and the Leverhulme Trust, the Southampton team is working to record precise 3D representations of the gestures used in conducting, from the hands, whole body and even facial expressions. When that data has been preserved and properly catalogued, researchers and aspiring conductors will be able to access it in order to gain greater insights into the biomechanical intricacies involved in the undertaking the artform.

There is no single "right" or "wrong" way to conduct, but there are specific gestures on which conductors rely that newcomers can study. A right-hander will traditionally hold a baton in that hand, which they use to control the tempo of the music, including signaling the beginning of an up or down-beat. Meanwhile, the left hand is free to take on other tasks. A conductor may point to individuals to give them their cue, or to tell sections when to taper off. It is a language of its own that transcends spoken words.

Initially, the Southampton team planned to create an exhaustive taxonomy of conducting gestures using traditional methods, but soon realized that the fluid nature of a conductor's movements would make such an undertaking unreasonable. The smarter solution was to catalog the movements of multiple conductors using motion capture, something that had never been done before. This required cameras designed to capture the most precise movements of an individual from multiple angles. For that, the team looked to Vicon.

"In order to capture the movements, gestures and skills involved in conducting, we needed to capture from both high and low positions, including the body, face and both hands," said Dr. Metcalf. "Our normal setup in the biomechanics lab at Southampton is great for many of our shoulder biomechanics work or gait analysis, but this project was unique and required something very specific. Vicon kindly brought extra cameras and helped us create a bespoke camera setup based on our capture needs."

The Southampton research team has a proven history when it comes to using Vicon's mocap cameras to capture data. During her Ph.D. dissertation in 2003, Dr. Metcalf utilized small volume motion capture to investigate the relationship between movement and function of the wrist and hand. She later applied those findings to a 2012 project titled "PianoHAWK," in which passive markers were affixed to the hands of piano players to gather data on how pianists develop their skills and how that might help to improve methods for rehabilitating repetitive strain injuries (or help them alter their techniques to preclude injuries altogether).

Southampton has used Vicon technology beyond music as well. In 2016, a study titled "Life at the Cutting Edge" sought to develop methods for assessing skill and expertise within an archaeological context. Participants wore passive markers on their hands and wrists while peeling potatoes using replica prehistoric tools. The use-wear profiles of replica tools were then assessed to help understand the skills used during prehistoric times.

In all cases, the use of mocap has seen new technology re-examine and improve old practices.

To ensure that the "Capturing the Contemporary Conductor" study received sufficient data, conductors and musicians performed in Southampton's research lab, which is outfitted with several Vicon T-Series cameras, one 360-degree video camera, stereo and close microphones, and a Microsoft motion-sensing Kinect 2 camera. Once the lab was set up to receive the musicians, the team recruited three subjects: Geoffrey Paterson, Holly Mathieson and Dr. Oliver (who pulled double duty as conductor and researcher).

Each conductor wore wireless EMG (electromyography) devices on their biceps and triceps in addition to markers on their faces, hands and body. The conductors then stood on force plates to measure the impact of each gesture. The research team next moved on to recording the facial gestures of each conductor. To accurately reflect this, a few different solutions were attempted with the assistance of Vicon. After trying different pieces of facial capture hardware, the team eventually settled on passive markers on the face of each subject.

For their mocap performances, Dr. Oliver composed a new three-movement piece titled "Captured: Three Mocap Experiments for Conductor and Small Ensemble," scored for seven instruments: oboe, bass clarinet, trumpet, electric piano, percussion, violin and double bass. Each of the three movements is designed to challenge the conductors in different ways. For example, the first movement involves managing strange time signatures at different speeds, while the second movement requires the conductor to coordinate the entrances of the ensemble, but not necessarily to conduct them in a traditional sense.

In effect, the variety of musical materials across the three movements ensures that the conductors are required to perform a wide range of gestures to successfully coordinate the ensemble. Microphones were fixed above the conductors and near each instrument to capture detailed sound recordings via post-production software Steinberg Nuendo. The audio was then synchronized to the Vicon gear using SMPTE time code.

"Partnering with Vicon allowed us to get the results we needed. Other mocap solutions either lack precision or require bulky sensors attached to subjects, which wasn't feasible given the movements involved," said Dr. Metcalf. "Vicon's optical motion capture is currently the only solution that offers good precision and reliability, and minimizes interference with the movements."

Southampton's "Capturing the Contemporary Conductor" combines biomechanics and music using the most cutting-edge motion capture and motion data technology, alongside audio and video recordings. The results will offer researchers, aspiring conductors and fans of orchestral music a new resource, and it will be available through open online access.

The art of conducting may be hundreds of years old, but technology is helping bring it to a new generation for the first time.

The art of conducting may be hundreds of years old, but technology is helping bring it to a new generation for the first time.

HUMAN MEDIA LAB TAKES LEGO® TO THE NEXT LEVEL

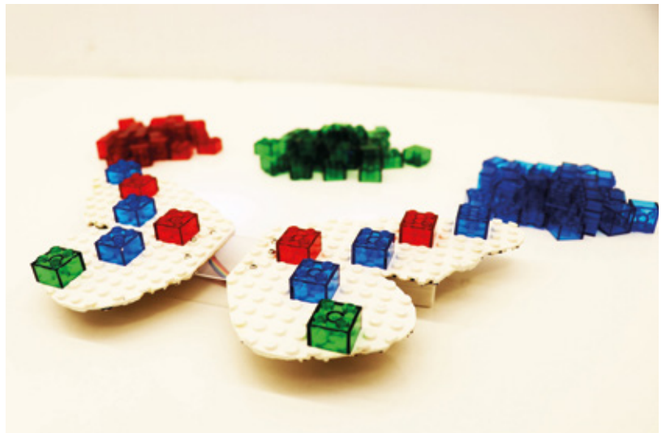
USING MOTION CAPTURE CAMERAS, QUEEN'S UNIVERSITY'S HUMAN MEDIA LAB HELP CREATE FLYING LEGO BRICKS THAT COULD MIMIC REAL WORLD MOVEMENTS

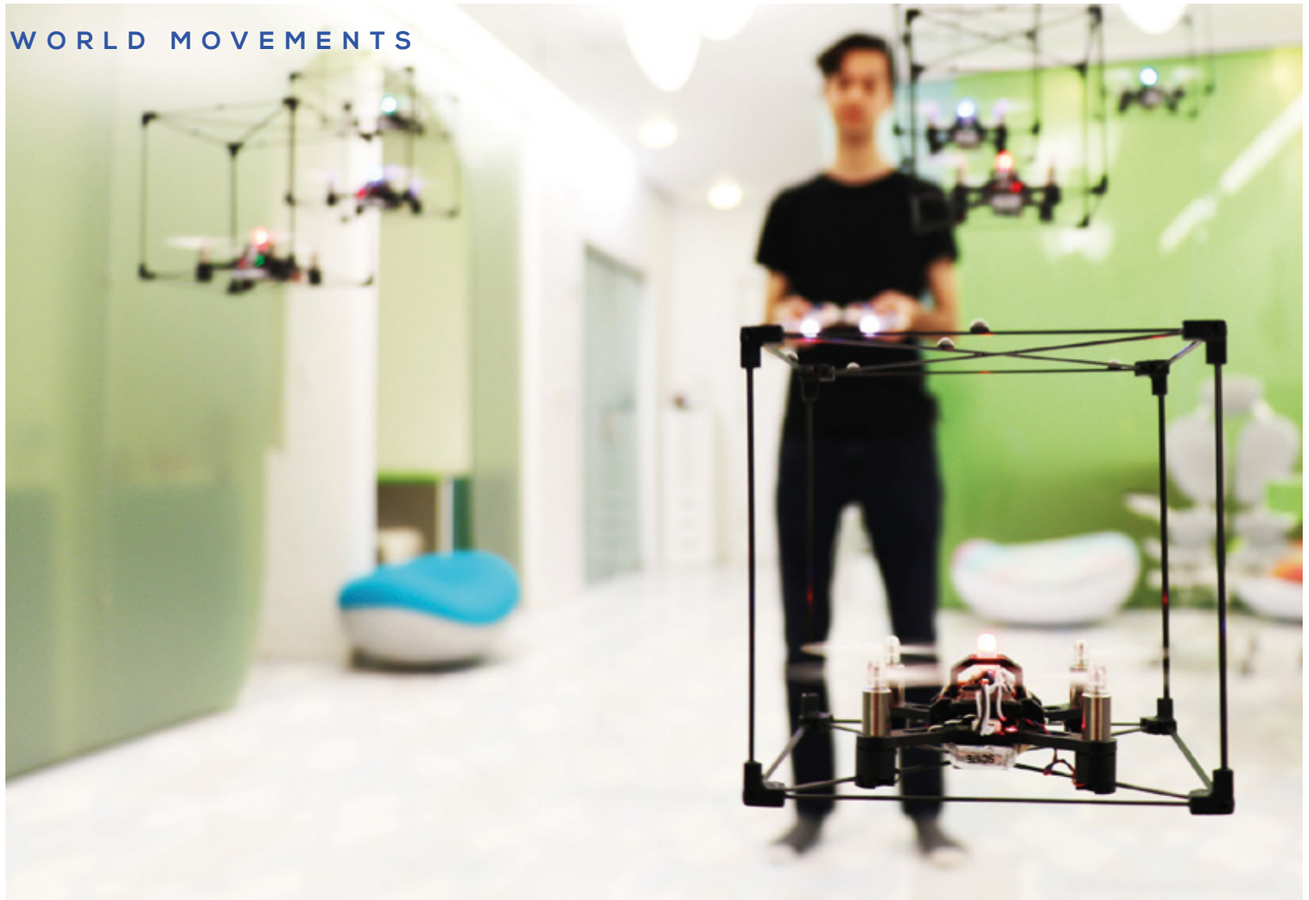
For more than half a century, Lego building blocks have sparked the imaginations of both children and adults across the globe, helping to transform imaginative concepts into concrete (or, more accurately, plastic) reality. Now, thanks to a collaboration between Queen's University in Ontario, Canada and Lego Creative Play Lab, Lego's bricks are finding their way into a new dimension.

By applying passive markers to colored Lego bricks, researchers at Queen's Human Media Lab (HML) are able to create a flying robotic swarm capable of mimicking the movement and placement of specific Lego bricks. To demonstrate this, HML created a flexible, gyroscopic controller that looked like a butterfly. Users could then place red, green or blue bricks on the butterfly controller, and small quadcopter drones with matching colors flew into the air in a formation exactly matching the layout on the controller. Users could then turn, flip or bend the controller and the drones would mimic the movements in real-time.

Swarm robotics is still a relatively young field in the world of robotics, in part due to the technology needed to achieve an accurate swarm. It's one thing to command several small robots all at once, but it's another to have them move in unison – that requires precision tracking.

To record drones in flight, the team at HML currently uses Vicon T-series motion capture cameras, capable of tracking dozens of moving objects at once at 120 frames per second. These cameras can isolate and record the movement of each drone without issue, then send that data to Vicon's Tracker 3 software, where it can be controlled using a peripheral device -- even a Lego controller.





> "With this technology, we are able to simulate the physics of the natural world like gravity, planetary orbits, and more, giving children a chance to see what they have long learned from textbooks and two-dimensional depictions, in a real physical environment."

HML showed off its cool new Lego-infused project in February 2018 at the Lego World Expo in Copenhagen, Denmark, where attendees young and old took to the skies with their designs. While this might be one of the most sophisticated uses of Lego bricks to date, the brick-maker is no stranger to robotics.

In 1998, Lego introduced the "Lego Mindstorms" line, introducing "intelligent bricks," capable of receiving basic programming that allowed them to perform simple, task-oriented movements. The product line included a brick computer that controls the system. It worked with a set of modular sensors and motors, along with Lego "Technic" bricks designed to build mechanical systems. Lego's robotics endeavor created a relatively small but passionate fanbase, leading to global competitions and ushering a new scientific-focused side to the massive Lego brand.

As youth robotics programs have proliferated, competitions like FIRST Lego League -- where young builders create Lego-based solutions to real-world problems -- have kept pace. Given Lego's history with robotic systems, it made the partnership with HML a natural fit.

Queen's University's HML is known for its groundbreaking work developing flexible displays, having created interactive displays (read: touchscreens) on non-flat surfaces like soda cans and even bendable tablets. The collaboration with Lego is an extension of HML's BitDrone system, which initially debuted in 2015.

HML's BitDrones project began as a 3D modeling tool. Programmers used it to model several unique scenarios, including one where you could navigate a file folder using touchpads on drones. Each drone contained a digital readout to represent files or subfolders, and the Vicon system recorded the movements. Lego bricks weren't yet in the equation, but even then HML Director Dr. Roel Vertegaal acknowledged the system's resemblance to the building blocks.

"They sort of resemble flying Lego bricks, but the application goes beyond simple toys," said Vertegaal.

Currently, HML's BitDrones are relatively large, which works fine for demonstrations using Lego bricks. The goal is to make them smaller, so that the swarm can act like a form of interconnecting programmable matter. In a similar vein, HML aims to make the system work with far bigger drone swarms. While users at the Lego World Expo controlled no more than ten or fifteen drones at once, the team at Queen's is hoping to push that number into the hundreds, or even the thousands.

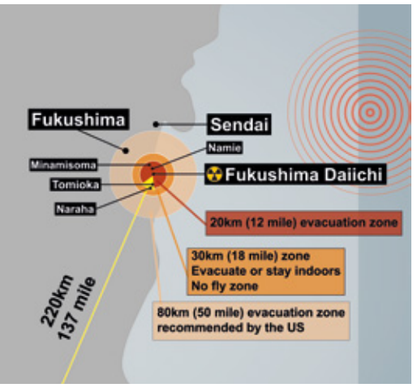
Although amazing crowds is a nice bonus, the program's potential reaches in multiple directions, opening up new possibilities for students and professionals alike. For instance, "DisplayDrones" -- one of three BitDrones revealed at the 2015 ACM Symposium for User Interface Software and Technology -- are fitted with high-resolution cameras of their own, allowing users to control the drones with simple head movements while teleconferencing. With this tech, prospective buyers could remotely inspect a home, business partners could take a self-guided tour of a model property and much more.

Vertegaal also believes the technology could help revolutionize the ways in which we teach physics to children.

"We believe [the BitDrones project] has the potential to take experiential learning to an entirely new level," said Vertegaal.

PUSHING THE REALMS OF THE POSSIBLE ONE ROBOT AT A TIME

THE JAPAN ATOMIC ENERGY AGENCY IS WORKING TO TEST AND REFINE THE FUTURE OF ROBOTICS USING MOTION CAPTURE ANALYSIS TO DRIVE DEVELOPMENT



The Fukushima Daiichi nuclear plant is helping to create a brave new world for robotics and a platform to test new systems and equipment to speed the cleanup process.

Recovering from the 2011 events at the plant will take many decades, as it is hampered by the inability to use humans in the work.

This is where the Japan Atomic Energy Agency (JAEA), a government body working on the clean-up, comes in. At its facility the Agency invites companies in to test their equipment in conditions closely resembling those at the former power station.

Each mission into the radioactive area requires intense planning, training and coordination, leading to an innovative new facility with multiple training areas. Many Japanese companies are coming to the Agency's facility to test the robots and systems that they are developing to handle the clean-up.

Time is of the essence during missions into the radioactive area. Even the most advanced robots on the planet are vulnerable to the conditions they will face, the JAEA test centre has been purpose-built to provide the three key environments found at the Fukushima Daiichi plant:

- An underwater area with a five metre deep pool
- A set of stairs with varying tread depth and height – something notoriously difficult for robots to encounter
- A motion capture system with a volume of 15 by 15 by 7 metres to test both ground and air robots

> It took six years of experimentation and advancements, but the team managed to create a new type of robot that it dubbed the 'Mini-Manbo,' or 'little sunfish.'

Each of these environments is providing unique learning experiences. Robots tested at the Agency's facility are being prepared for the myriad of highly rigorous environments faced on-site at the nuclear plant. Radiation causes circuitry to fail, making wireless communications with the robots impossible, and the robots need to be shielded to protect their vision systems.

On top of this, debris presents a surprisingly large part of the challenge. In Japanese, the word 'gareki' is a simple one with a myriad of different meanings. Gareki does not just mean rubble, from small to large – it encompasses an environment of radiation, twisted staircases, debris-filled water and complete darkness.

The worst scenario for a robot facing gareki in its many forms is to break down. When that happens, the robot becomes just another piece of gareki that future missions need to account for.

Equally drones are not immune to the challenges of gareki. While useful for surveillance, the areas the drones are assigned to survey are dark and filled with unpredictable conditions. Interference from radiation makes controlling them even more difficult, and a single wrong move can lead to a new piece of gareki to deal with.

This is where the JAEA's three training and test facilities come into their own. Because each is designed to help solve a different challenge and equipped with cutting-edge technology, planning here pays off in the tough real-world environment.

At the test pool, human operators trial new robots in the tank, simulating the conditions of the water precisely.

They can then spend hours testing new robots on the stairs, stairs that can be altered to exactly match those – and the damage they have incurred – at the plant. Here each test is recorded using Vicon's Vero motion capture cameras, capable of tracking the robot's movement precisely, down to the millimetre. An added bonus of this system is its ability to be moved to different locations within the testing facility, easily.

"JAEA provides a detection and measurement service to all the companies working in the clean-up zone," the Agency stated. "For that reason, we need to be able to switch quickly between robots with different capabilities – for example air, ground and stair climbing. The Vicon motion capture system gives us the capability to accurately and quickly change the setup."

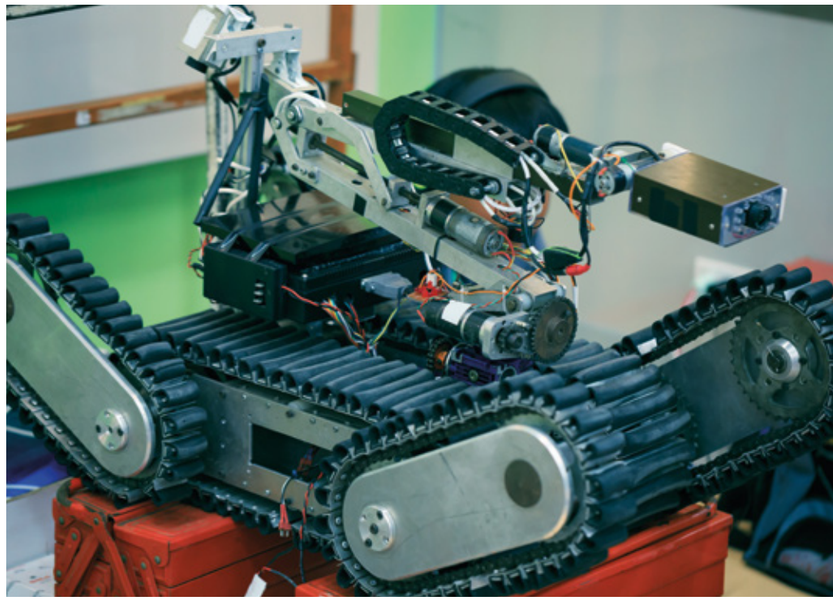
When testing in the motion capture lab, robots are put through their paces to exacting standards. The robots need to be able to carry out minute, accurate movements, so the lab uses Vicon's T-Series cameras, that offer the level of precise feedback that the JAEA needs.

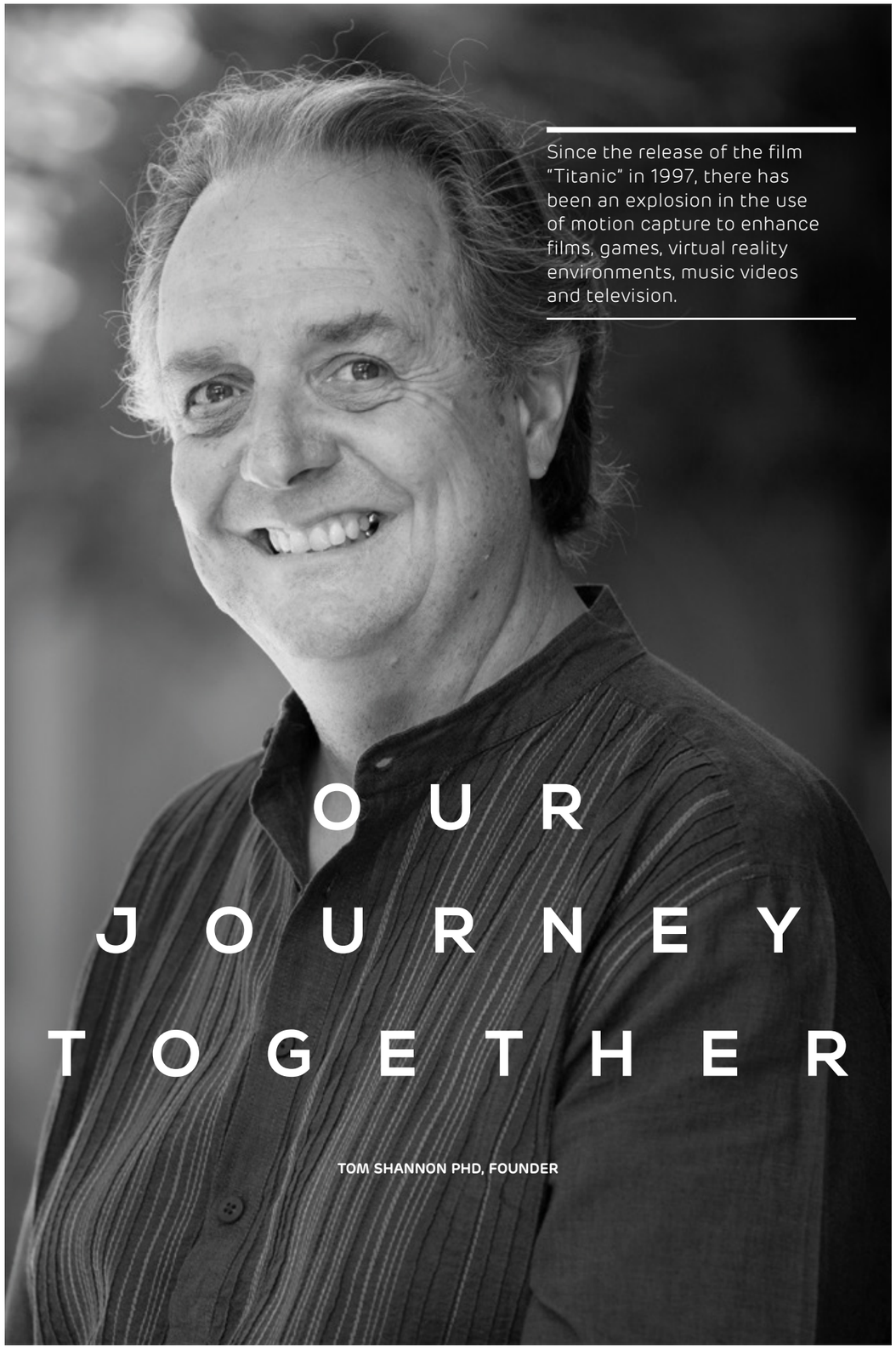
Engineers at the Agency's facility are using the Vicon system daily and are impressed with how easy the software is to use and the accuracy of the cameras.

Hand-in-hand with this, companies coming in to test their robotics systems in the facility come away with a highly positive experience of the ability and flexibility of the Vicon system, particularly when it comes to the Vero system on the stair set-up.

While the clean-up of the Fukushima Daichii Nuclear site is incredibly complicated, and the environment as challenging as anywhere on earth or in space, Vicon is playing a key part in supporting the JAEA and is pleased to be a part of the unique solution needed to rehabilitate the site.

From this work will come some of the most advanced robots ever seen, advances that will be felt in many types of different industries for years to come, thanks to the testing carried out at the Agency's facility.

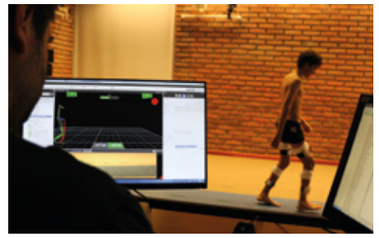




Since the release of the film "Titanic" in 1997, there has been an explosion in the use of motion capture to enhance films, games, virtual reality environments, music videos and television.

OUR JOURNEY TOGETHER

TOM SHANNON PHD, FOUNDER



Clockwise from left of this page: Paddington Bear, Vicon Nexus, Mars Rover

As we approach the 35th anniversary of VICON, it is an opportune time to look again at the wondrous journey taken to capture and better understand motion, whether it be human, animal or even of inanimate objects. In 1826, Joseph Nicéphore Niépce introduced what would become the precursor of the modern camera, giving scientists, anatomists and clinicians access to photographic images capable of instantly recording and characterizing the locomotion of humans and animals. In 1878, in order to win a bet, Eadweard Muybridge used this new technology to acquire sequential images of a horse at full gallop, setting him on a life-long quest to study human and animal movement though creating his iconic, but qualitative sequences of photographic plates.
Inspired by the work of French scientist Étienne-Jules Marey, Professor Christian Braune and his student Otto Fischer successfully quantified three-dimensional human gait for the first time by simultaneously capturing the motion of a subject from two different viewpoints -- although it took them 12 months to complete the calculations. For much of the latter part of the 19th and first half of the 20th century, exhaustive and tenacious work by these researchers and many others was undertaken to capture and to extract meaning from measurements, with the objective of enlightening clinical understanding.

In the 1960s, the opportunity to conduct routine gait analyses was made possible through the hand digitization of planar coordinates from two or more cine cameras with a photogrammetric reconstruction into 3D data points. The arrival of high efficiency retro-reflective materials, affordable computers and optically stable video cameras in the late 1970s and early 80s were key in helping to develop reliable apparatuses that could automatically reconstruct, label and track points in time and space. The commensurate development of validated gait models along with the clinical acceptance of the efficacy of the approach, helped to thrust the technology into biomechanical research and orthopaedic mainstreams. Many subsequent advances improving the models, point and trajectory reconstruction accuracy, ease of use, availability and measurement consistency.

Roy B. Davis and Sylvia Õunpuu described the clinical application of movement analysis as collecting "information to aid in the understanding of the aetiology of presenting gait abnormalities and to assist in treatment decision-making." To this day, the interpretation of acquired kinematic and kinetic data remains in the hands of interdisciplinary teams with substantial knowledge of normal and pathologic gait, where characteristics are measured, abnormalities are identified, causes are postulated and treatments are proposed.

The engineering problem of reliably capturing and tracking points in space has long been solved, but research continues to better understand the association between the precise measurements of bony landmarks on the skin surface and the actual location of the underlying skeletal structures during motion. This is commonly described as the "soft tissue artefact," which was so elegantly described by Dr David Sutherland as trying "... to measure the movements of a broomstick within a gunny sack," Many researchers have proposed techniques to identify joint centers and axes functionally, through fitting the data to an idealized joint model that also incorporates some form of soft tissue artefact compensation. This work continues and, like the earlier innovations, is rapidly gaining acceptance through close collaborative efforts between clinicians, scientists and engineers in laboratories, academia and industry across the world.

The need to quantify sporting performance has also resulted in the development of cameras with significant improvements in quantum efficiency, speed and resolution that are capable of working outside the laboratory to track fast and subtle motions with consistency. Access to this new technology has meant that the motion of the Mars Rover over desert terrain could be measured together with many other new and exciting applications, such as tracking swarms of quadcopters and even measuring the locomotion of kangaroos.

Since the release of the film "Titanic" in 1997, there has been an explosion in the use of motion capture to enhance films, games, virtual reality environments, music videos and television. The technology has helped bring many stories to life that were thought to be almost impossible before the ready availability of the technology to the entertainment sector. With it have come many challenges, including the need to capture the motion of multiple characters simultaneously, in large volumes and with high camera counts. The entertainment sector has also demanded improved subtlety in the measurement of the motion of hands, feet and facial expressions, with a need to provide real-time reconstruction of the animated characters who may or may not be humanoid.

The demands of life sciences -- including clinical gait analysis and sport, engineering including ergonomics and the entertainment sector -- has resulted in a synergy that has driven and improved the core technologies for the benefit of all.

In just one example, the life sciences community's need to continuously improve skeletal modeling has benefited animators in creating ever-more realistic characters, whilst their requirements have directly improved how the technologies are applied and data are presented within the clinical gait and biomechanics communities. In the coming years, there are great opportunities to enhance the performance of Vicon motion capture through drawing on the expertise of our inertial measurement specialist colleagues who have brought to us their wide experience in the application of an entirely different, but commensurate technology.

A central tenet since our foundation has been to support and closely collaborate with our academic, clinical, engineering and entertainment customers and friends.
Much has been achieved but with new emerging technologies on the horizon and more to do, our journey of discovery together is only just beginning.

VICON EVENT CALENDAR

2019

TheStandard

JANUARY

APTA CSM
23-26 Jan

FEBRUARY

MARCH

GDC
18-22 Mar

GCMAS
26-29 Mar

APRIL

SCCB
5-6 Apr

CMAS
25-26 Apr

MAY

ACSM
28 May-1 Jun

JUNE

ISPGR
30 Jun-4 Jul

JULY

ECSS
3-6 Jul

WCSMC
8-10 Jul

ISBS
21-25 Jul

SIGGRAPH
28 Jul-1 Aug

ASB / ISB
31 Jul-4 Aug

AUGUST

CMBBE
14-16 Aug

SEPTEMBER

ESMAC
23-28 Sept

OCTOBER

NOVEMBER

VR Days
13-15 Nov

DECEMBER

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