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From the SelectedWorks of Christopher Joyce

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FINDING THE PERFECT GOLF SWING

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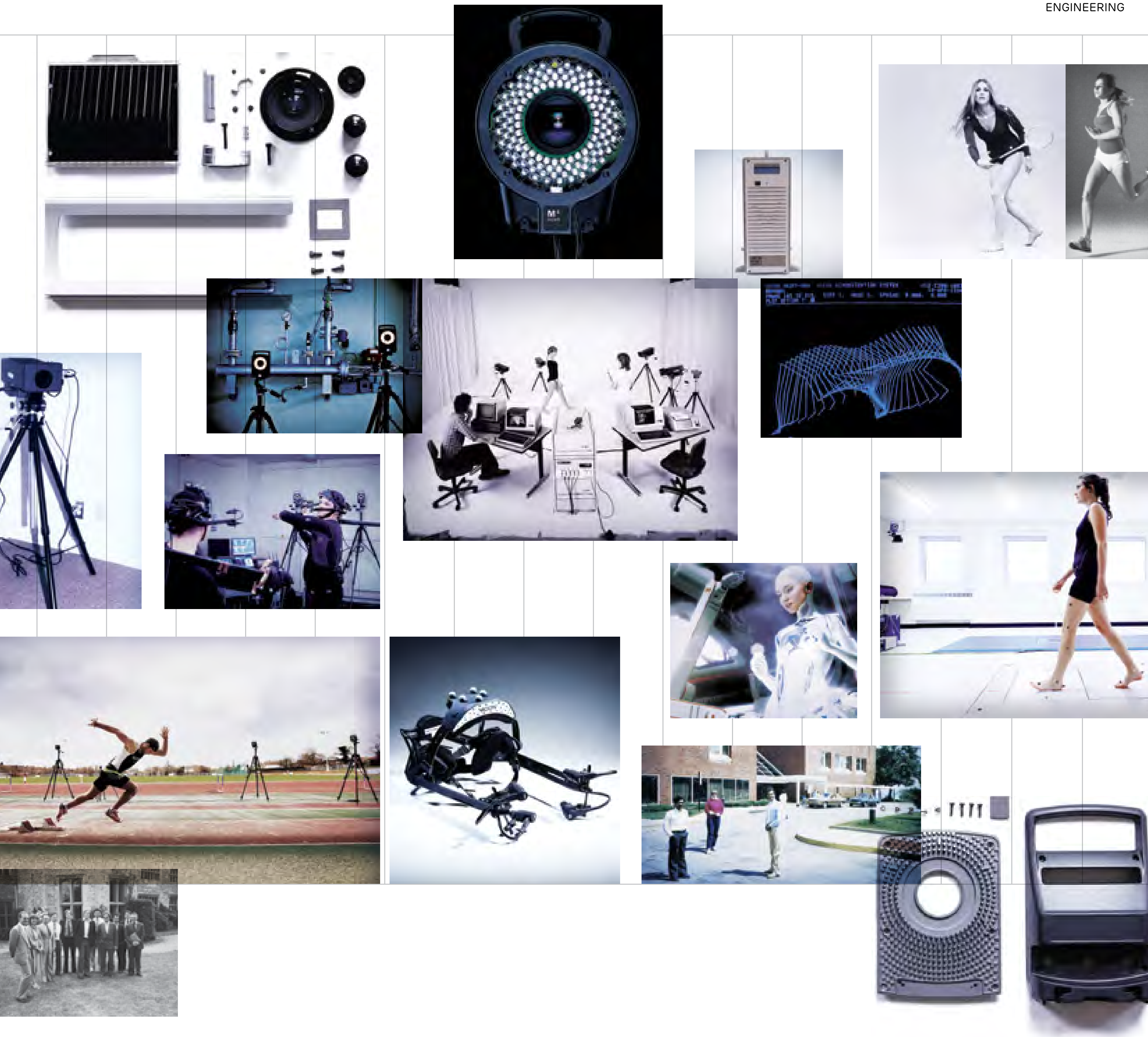
TheStandard

VICON'S 30TH BIRTHDAY EDITION

LIFE SCIENCE
ENTERTAINMENT
ENGINEERING



VICON

A WALK DOWN MEMORY LANE

One entirely deliberate feature of this short history is that it makes no mention by name of any former and current employee. For a company that has always believed that it exists only through its employees, this may be thought an odd decision. But the fact is that there are so many people, past and present, who have made key contributions that there is simply not space to do justice to them all. They are constantly present in our collective memory and present actions.


BY JULIAN MORRIS AND TOM SHANNON
FOUNDERS, VICON

The name Vicon is an abbreviation of "Video Converter". This gives some indication of the state-of-the-art at the time the first Vicon system was developed.

Measurements of human motion, particularly walking, have a long history going back to the beginnings of photography in the 19th Century. By the 1970s a fairly standardised methodology had emerged. Two, three, or even four 16mm cine cameras running at 25 or 50 frames/second were placed to the sides and in-line with the walking subject. The film strips were sent to a lab for developing and then placed one after the other in a "digitising projector". This device allowed the two-dimensional coordinates of points on the body to be measured and transferred to a computer. Although extremely laborious, often taking several days for a single gait cycle, this type of system was used for seminal pieces of biomechanical research, including Paul's pioneering estimates of hip joint loading which paved the way for the design of reliable total joint replacements. (John Paul died late last year and a short obituary appears elsewhere in this edition.)

This situation was clearly never going to allow this branch of biomechanics to advance beyond isolated and laborious research projects, so a number of academic engineers, notably Winter in Waterloo, Furnée in Delft, and Paul, Jarrett and Andrews in Glasgow, began to consider the design of more automated systems. The Departments of Engineering Science and Orthopaedic Surgery in Oxford joined one of these largely collaborative projects in 1977. In 1979 Oxford Dynamics (the original name of Oxford Metrics, and part of Oxford Instruments) decided that the technology had commercial potential and licensed prototype designs. Under the name Vicon, Oxford Dynamics redesigned the electronics to suit rapidly-evolving minicomputers and made the revolutionary decision to turn a bi-planar 2D measurement system into a photogrammetrically-calibrated 3D kinematic measurement system. The first Vicon systems were shipped in 1981 to University of West Virginia (sheep walking on a treadmill), Boston Childrens' Hospital (clinical gait analysis), and Saitama Rehabilitation Hospital (also clinical gait analysis). In all three cases, the computers were housed in special rooms as large as some modern gait labs.

In 1983, Oxford Instruments floated on the London Stock Market in order to fund and focus on the rapidly-growing demand for its superconducting magnets for nuclear magnetic resonance imaging. Along with several other OI businesses, Oxford Dynamics was purchased by its staff and began life in July 1984 as Oxford Metrics Ltd in an asbestos-roofed shed about 100m from its present site. As indicated above, Vicon was from the start a global business and it is interesting to recall that the primary means of communication with overseas customers and distributors was telegraphy ("Telex") running at about one word per second.

From the start, the fledgling business had a small and lumpy revenue stream from sales of Vicon systems which allowed it to continue development of the product and to increase staff from the initial five. It was largely unclear where the main growth opportunities lay. The terms "clinical gait analysis", "motion capture", and "CGI" had yet to be coined. But early Vicon customer requirements included precursors of most of today's major markets and applications, including prosthetics and orthotics, gait analysis for neuromuscular disability, sports performance and injury avoidance, vehicle safety and ergonomics, robotics and aerospace. The notable absence was any motion capture for film animation and computer games.

In the late 1980s and early 1990s, a growing number of hospitals were starting to perform complex orthopaedic and neurosurgery to improve the gait of children with disabilities due to congenital conditions and perinatal trauma. They needed and were starting to evolve standardized methods of assessments, including gait analysis. Oxford Metrics decided to turn Vicon into a measurement system that included everything that was needed to support that standardization including software to perform biomechanical analysis right through to a clinical report. Considerable time was spent observing and discussing the practices and requirements of the leading hospitals and clinicians in the field. The majority, such as David Sutherland and James Gage, were in the US but the same standardized methods were also coming into use in Europe and other parts of the world. By 1993, Oxford Metrics could deliver a Vicon system and install it in an empty room to allow a hospital, with appropriate training of clinical staff but without a resident engineer, to start a clinical gait analysis service. A significant part of this breakthrough was the simultaneous emergence of personal computers with high-quality graphics.

In the mid-1990s, just as clinical gait analysis became standardized, an entirely new application for Vicon systems began to emerge. The generation of increasingly realistic computer graphics imagery (CGI) based on animated 3-dimensional computer models created a need to drive those models with realistic motion. Initially the need was simply to save time over hand-drawn animation but it was quickly realised that motion capture, as it became known, could also add nuance to the performance. The first users of mocap were pioneering CGI film facilities such as Industrial Light and Magic and Digital Domain but very soon afterwards computer game developers began to use similar techniques. Vicon benefited from an explosion of small game development start-ups, many in the UK. In some cases, a Vicon system was their first major investment.

Motion capture for animation quickly became a primary driver of new developments in camera and software technology to make Vicon systems larger, faster, and more accurate. New high-resolution image sensors were developed, cameras were designed with embedded microprocessors, digital networks replaced analog video cables. Improved software models calibrated to the body shape and motion of individual subjects allowed the flow of data through the processing pipeline from patient or performer to clinical report or CG animation to be made in "real-time". (Vicon raw data has always been measured in real time.) Vicon systems became quicker and easier to use.

While Vicon was evolving, Oxford Metrics was also growing in other ways. In 1999, 2d3 was established to exploit recent advances in computer vision, particularly methods using "structure-from-motion" shared with Vicon. In 2001, Oxford Metrics floated on the London Stock Market, becoming OMG plc. The Group has made a number of corporate acquisitions, including the merger of Vicon with Peak Performance in Denver which is today the location of the main Vicon office in North America. Specialist video image capture, tracking, and analysis, also provide the technology base for Yotta, Vicon's partner company within OMG concerned with the automated surveying and reporting of the condition of road networks and related infrastructure. Most recently, OMG has started a new business, OMG Life, to develop products for the rapidly-expanding consumer wearables market, starting with the Autographer camera.

After 30 years, perhaps the most remarkable thing about Vicon is this. Despite the extraordinary engineering developments that have been made in imaging and data processing, both inside and outside the company, a Vicon user from 30 years ago would recognise all the component parts of today's Vicon system and would quickly understand how to operate it. The fundamentals of Vicon measurement are unchanged. And the Vicon of 2044?

Management meeting of Oxford Medical Systems who formed Oxford Dynamics to exploit the emerging technology, 1978/79.

First Vicon Analog Camera

WELCOME TO VICON'S 30TH BIRTHDAY EDITION OF THE STANDARD.

2014 marks three decades of pioneering motion capture and the latest edition of The Standard reflects that history: this 66 page special issue showcases some of the most diverse, unique and successful Vicon customers, old and new.

Since 1991, The Standard has been celebrating the amazing work of our customers around the world. From Practical Planning to Establish a Gait Laboratory in 1991, Orofacial Movement Analysis in Infants in 2002, to A Hopping Success for Outdoor Capture in 2011. Although The Standard began as a Life Science magazine, in 2010 we expanded its remit to include the many exciting projects being developed in the Engineering and Entertainment markets, which has resulted in The Standard being more widely read than ever before.

We hope you enjoy reading this special commemorative edition and if you'd like to be featured in a future issue, please let us know at the email below or on our social media channels.

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NASA'S JOHNSON SPACE CENTER USES VICON SYSTEMS TO TEST SPACE SUITS AND VEHICLES

NASA'S JOHNSON SPACE CENTER

Nasa's reduced gravity plane.

BY VICON EDITORIAL TEAM

You may have already read about Vicon motion capture systems being used for the Oscar and BAFTA nominated, blockbuster hit Gravity, making Sandra Bullock and George Clooney look like they were floating through space dodging satellite debris. But what you may not know is that the same technology is used by NASA to prepare for real-life space missions. NASA's Johnson Space Center (JSC) in Houston, Texas has been using Vicon systems for more than eight years to test the designs of space suits and vehicles.

Although manned missions have been put on hold due to budget cuts, NASA is currently preparing for manned space exploration missions to Mars and the Moon in the coming years. Space vehicles, spacesuits and other hardware are very complex and costly to design and build, requiring numerous iterations to meet performance requirements and costing tens of millions of dollars. NASA's JSC needed a solution to help them design suits and vehicles that, when built, allow astronauts to function effectively.

Human-centered design

"The main issue was that we used to think of humans last," said Matthew Cowley, Senior Design Engineer at Johnson Space Center. "For example, we'd design and build a vehicle first, and then try to fit a person in it. But when we'd test them with real-life people in spacesuits we'd find that they couldn't function or move around in the vehicles properly." This could cause problems not only for the mission itself, but for the astronauts involved. So NASA's aim was to find a technology that would enable human-centered design.

NASA chose Vicon systems based on their quality and reliability. They currently use Vicon's Nexus software along with several different types of Vicon cameras, including the Vicon MX System.

Images courtesy of Framestore and Warner Bros. Pictures.

Transparent mockup of the new Orion spacecraft. Images courtesy of Johnson Space Center, NASA.

JSC engineers use the Vicon systems to ensure that new space suit designs allow astronauts to interact with vehicles and their environment unhindered. Examples include testing how astronauts and their space suits will perform if their vehicle breaks down and they have to walk several miles back to base with a limited oxygen supply. Or verifying whether the design of spacesuits and vehicles enables astronauts to reach and operate controls and safety equipment, such as fire extinguishers, while wearing their suits.

Design in motion

With Vicon systems, JSC spacesuit engineers are able to acquire a lot more information to better analyze the motions of different designs, helping them understand not only the gross mobility of the suit, but how each individual component contributes to overall mobility.

To test mobility, engineers used to have subjects move in certain directions, photograph them and then take measurements, which was more time consuming, less effective and less precise. Now they can have the subjects move in the suit and perform functional tasks to understand which joints they use and how much that joint contributes to the motion.

"The use of motion capture when testing suits is incredibly precise," said Amy Ross, Johnson Space Center Spacesuit Engineer. "Testing used to take hours and data analysis would sometimes take months, but now tests only last an hour or so and we can have data available much sooner."

With Vicon systems now in use, JSC can put humans first, allowing them to test how different designs will impact human performance in real-life environments in ways they never could before.

Partial gravity testing

NASA also uses Vicon systems to evaluate suited human performance in reduced gravity. To do this effectively, partial-gravity analog environments ideally need to allow unrestrained freedom of movement while accurately simulating partial-gravity kinetics. In previous studies, two partial-gravity simulations were used to characterize suited human performance. The JSC Space Vehicle Mockup Facility's (SVMF's) partial gravity simulator (POGO) was one of them.

A Vicon MX System was used to capture kinematic data in various environments. Retroreflective markers were placed on key parts of the body and hardware. Data was processed with custom-made inverse kinematic and dynamic models using Vicon BodyBuilder, which provided additional flexibility and precision over previous models used by the team.

"Vicon was particularly helpful with this partial gravity simulator test," said Cowley. "We were able to see differences with the Vicon system we wouldn't have been able to quantify readily with other methods of motion capture."

Testing the Cyclops satellite launcher

Vicon systems are also being used to test the new SSIKLOPS (Cyclops) small satellite launcher, which will throw small satellites into orbit from the International Space Station.

"We put the launcher and a satellite on a frictionless floor and used our Vicon MX system to test the precision, speed and trajectory of the launcher," said Cowley. The Vicon system allows JSC to calculate the exact angle the launcher needs to throw the satellites.

Spacesuit testing in a multi-purpose crew vehicle mockup

For a recent study, NASA needed to evaluate four prototype suits to compare their performance and select the preferred suit components and designs. They needed an advanced, high fidelity motion capture system to evaluate the suits in action in a transparent space vehicle mockup. NASA engineers used a Vicon system to collect suit mobility data, test seat-suit-vehicle interface clearances, and examine suit performance within a multi-purpose crew vehicle (MPCV) mockup. They tested range of motion for various tasks using subjects of different sizes - both suited and unsuited, and in pressurized and unpressurized conditions.

The data revealed that most of the spacesuits tested had sufficient ranges of motion for selected tasks to be executed successfully. Any failures for subjects to complete a task were generally due to problems with suit-vehicle integration, poor agility and perception with pressurized gloves, or field-of-view issues when the subject was seated - rather than insufficient mobility of the new spacesuits.

ARCHAEOLOGISTS GET ALL THE GLORY

CHATHAM UNIVERSITY

BY ERIN MARIE WILLIAMS
ASSISTANT PROFESSOR OF BIOLOGY

Tell someone you're an archaeologist and you've earned their instant respect and envy. Images of Indiana Jones and buried treasure quickly come to mind. When I tell people what I do, study the human biomechanics employed when making the earliest archaeological artifacts, they respond with a very loud silence. And if I actually show them the artifacts I'm referring to—simple flakes of stone and broken rocks—they begin to think that religion and politics might make for more appropriate conversation topics.

There is no doubt that the earliest tools in the archaeological record are visually unimpressive. They are, in fact, merely rocks that were intentionally broken, in the hope of removing sharp-edged flakes of stone, or to produce a sharp edge on the rock itself. Even a pile of such tools would quite likely go unnoticed if encountered anywhere but at an archaeological excavation. But these tools are our ancestors' foray into the world of technology. As such, they represent an enormous evolutionary step in the hominin lineage. And they contributed to a series of adaptations—hunting, increases in brain and body size, access to valuable food sources—that culminated in the emergence of our own species, *Homo sapiens*. So despite their humble appearance, it is hard to understate the significance these broken pieces of rocks had on all of us. They essentially enabled our ancestors to become human.

These tools, known as Oldowan tools (named after Olduvai Gorge, Tanzania, where the famous Leakeys discovered them), begin showing up in the human archaeological record around 2.6 million years ago. Endless brain-hours have been dedicated to trying to figure out what changes occurred in our lineage around that time that facilitated the making and use of these early stone tools. Evolutionary biologists agree that whatever changes occurred, likely included both cognitive and anatomical components. My colleagues and I focus on the latter.

Humans have been evolutionary blessed with highly dexterous hands and an upper limb well-suited to manipulative tasks. But this wasn't always the case. The human fossil record shows us that 3.5 million years ago the shoulders, the arms, hands and wrists of our ancestors were quite different than our own. Back then, our ancestors were more similar to modern chimpanzees in some respects. The question my colleagues and I are trying to answer, is whether the changes seen in upper limb anatomy might be linked to stone tool behaviors. More specifically, does our modern upper limb anatomy offer any biomechanical advantages for using and making stone tools compared with the anatomical configuration of our ancestors? Could the changes we see there have enabled our ancestors to more efficiently or effectively engage in stone tool behaviors?

Because time machines are hard to come by, we use Vicon Nexus and some very complex-looking shoulder and wrist braces to investigate this question. Prior to the dawn of 3-D motion analysis, we lacked a way to quantify the movements of stone tool behaviors. Which meant that we could only indirectly measure efficiency and performance by comparing variables such as the time it takes to make a tool or the number of flakes that can be removed.

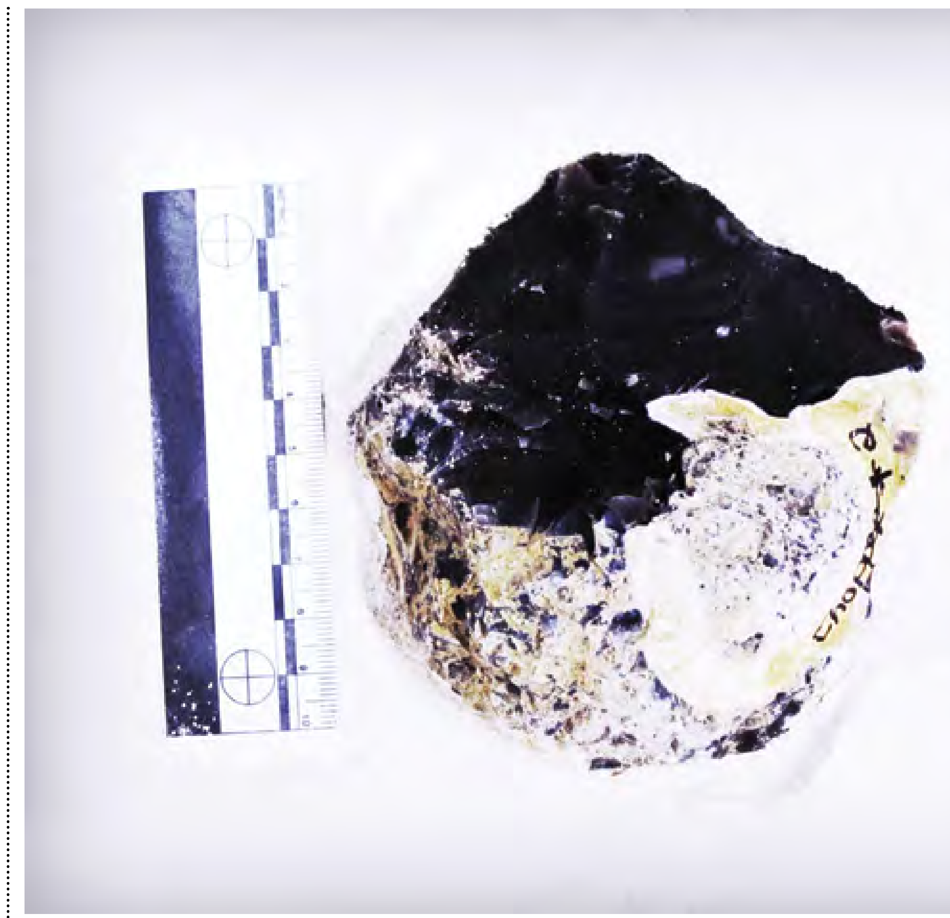
With Vicon, we are now able to capture data that accurately describes joint velocities, accelerations, and torques in order to create a complete biomechanical picture of the tool-making and tool-using processes.

If one visits the Motion Capture and Analysis Laboratory at The George Washington University where we gather our data, one is likely to encounter a somewhat uncomfortable volunteer clad in a tight tank top and biking shorts, and covered in reflective orbs while engaging in a range of rather odd behaviors. My collaborator, Dr. Neil Roach, and I, recruit stone toolmakers from all over North America to visit the lab in Washington, DC, in order to participate in ancient tool making and tool using activities. Many of these volunteers are more accustomed to making the types of beautiful, delicate stone blades seen in art museums. We ask them to make far simpler stone objects by banging rocks together until they have removed a few flakes.

They also crack open nuts and leg bones of large animals using rounded stone cobbles, butcher animal tissue using the tools they've made, and carry out other activities that we know our early ancestors carried out using stone tools.

After each volunteer goes through a series of early tool behaviors, we place them in the various braces and ask them to do it all over again in each one. The braces are meant to mimic different aspects of the ancestral anatomical condition. For example, the wrist brace we use limits wrist extension to about 35°, which may have been the limit seen in two of our ancestors, *Australopithecus anamensis* and *A. afarensis*.

Image courtesy of
Chatham University



With Vicon, we are now able to capture data that accurately describes joint velocities, accelerations, and torques in order to create a complete biomechanical picture of the tool-making and tool-using processes.

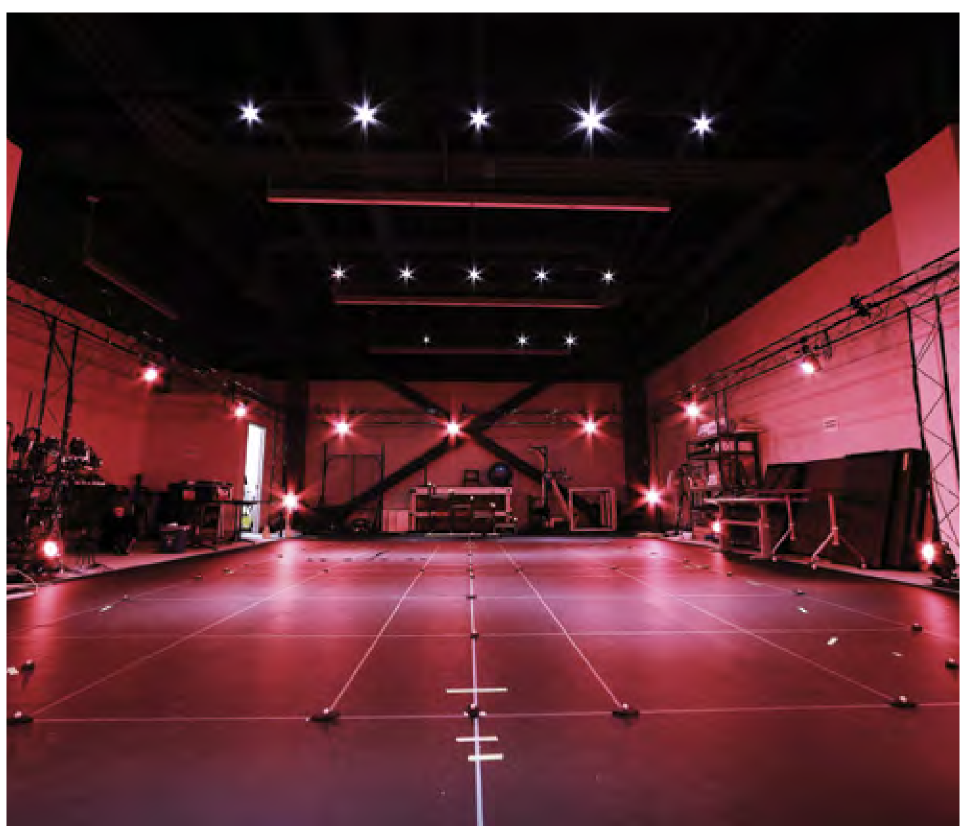
Erin Marie Williams

Working with Drs. Alison Brooks, Brian Richmond, and Adam Gordon, we are comparing the unbraced and braced kinematic strategies in order to determine whether any patterns emerge that distinguish the two conditions. Thus far, we have been able to demonstrate that our modern upper limb anatomy does in fact offer some big biomechanical advantages over the forms seen in some of our ancestors. For instance, our modern anatomy allows us to be more efficient and more accurate than the ancestral condition. And our ability to reach high levels of extension may help us avoid injury and osteological degradation in the wrist. All of this could have had large consequences that acted on the fitness of our ancestors. Individuals that were able to expend less energy or avoid injury while engaging in important stone tool behaviors would certainly have had an advantage over less efficient or injury-prone competitors. After all, on the African Paleolithic landscape, the ability to quickly butcher an animal and move on before other carnivores arrived could have been the difference between reaching reproductive age or becoming the prey of another competitor.

We will never know for certain how our ancestors moved their arms and hands and wrists when engaging in stone tool behaviors. We will never know a lot of the most interesting details about the species that came before our own. But motion capture technology has opened a window into human biomechanics and the movement strategies used to create the earliest artifacts in the archaeological record. Such an ability would surely impress even Indiana Jones.

Q+A WITH BUNGIE

The Standard caught up with Troy McFarland, Mocap Lead at Bungie, to discuss mocap tech, epic performances and projects old and new.



Bungie's studio before the re-vamp
Image courtesy of Bungie

BY VICON EDITORIAL TEAM

Why did Bungie choose Vicon as its motion capture system?
Before I came on staff, Bungie had already looked at a number of motion capture solutions. We chose Vicon because the hardware is the best on the market. We were looking for something that had incredible accuracy, was fairly easy to use, could handle the wide variety of motions and talent we'd throw its way, and could expand easily. Also, having a solid track record and knowing Vicon would be around for a long time was a factor. It would have been too risky to get a system that might not have any support a year after we got it.

How long have you been a Vicon customer?
I've been a Vicon customer since 1997 when I worked for Dynamix, the creators of "Tribes" among other things. Back then, we had only seven Vicon 370 cameras that shot at 60fps. It took a huge warehouse just to get a 16' circular volume that could handle only one or two talent at a time. That project was a lot of fun to work on, but we can do so much more now!

What system do you have now and has it changed over the years?
We started with 16 MX40 cameras. Back then, the cameras were mounted on the same truss that held a large black privacy curtain. The QA department was on the other side of the curtain, and sometimes after a particularly epic performance, you could hear them trying to stifle their giggles. At the time, we only had three set pieces: a ramp, a pull up bar, and a crash pad. But, they were enough to get what we needed for Halo: Reach.

We now have a hybrid Vicon system, consisting of six MX40 cameras, 16 T40 cameras, and 12 T40S cameras, along with two video reference cameras, and up to four face reference cameras and mics, all in its own dedicated studio.

The on-site dedicated mocap studio at our present location is a huge step up from our old studio in Kirkland. We've now got room to store a few more props and set pieces. We've covered the walls with sound abatement material that is also really bright for better video reference. The floor used to be black rubber, but we've upgraded that to the brightest carpet we could find, to help bounce light to the talent for better face video reference too. Speaking of which, we recently installed eight incredibly bright LED banks with custom diffusers to provide even lighting throughout the studio.

Troy McFarland, Bungie

Bungie's new studio has extra overhead lights and bright carpet to reflect more light to the actors face

Images courtesy of Lorraine McLees

Bungie is a developer of kick ass games that combine state-of-the-art technology with uncompromising art, captivating storytelling, and deep gameplay.

For set pieces, we've kept the trusty pull up bar, and added a few more items. I created an adjustable staircase out of unistrut. We also have a platform that is used in a fair number of shots. We have a wire mesh wall that minimizes occlusion with applied dynamat to keep down the noise when it's hit.

We're always evolving and offering more services to the development team.

Does Vicon hardware and software make your job easier?
Absolutely. I've used other systems in the past, and it certainly has advantages over them. It is a lot easier to do stunts with a passive optical system. If a marker breaks, it's very fast, cheap and easy to replace it. And because the suit isn't powered, we don't have to worry about a dead battery or a torn cable messing things up. Also, we don't have to worry about rebar in our floor throwing off any of the data, as we might with a magnetic system. I've yet to find a more accurate system.

One thing to realize is that at Bungie, mocap data is used in a variety of ways. Ultimately, it is just another tool for our incredibly talented animators to use. Sometimes they just grab poses and timing from the data, and exaggerate them to bring them up to our stylistic quality bar. Other times, it's used as a base layer, with additional changes layered on top. But, all animations have to pass our high quality bar before it makes it into the game.

Has the development in motion capture technology in the last 10-15 years made a difference to the type of projects Bungie can take on?
It wasn't until Reach that it made sense for Bungie to even look at motion capture. In the past, systems either took up too much space to get a decent volume or were too expensive for most studios to own. With newer systems being able to use wider angle lenses, we've been able to get larger volumes in smaller places, and the price tag to quality bar ratio has gotten better.

When I first started using mocap, there was no real time preview, no auto labeling, and no easy way to have multiple talent in the same space. I don't even think the software on the market had name spacing back then! There was no easy way to synchronize or even trigger video or audio reference. And, the volume size was pretty small back then, even with a huge studio in which to shoot.

Because of this, cinematics were practically impossible to shoot. But, I did actually shoot a NASCAR pit crew, using one talent. We had to use click tracks on our speakers, so he would know where to be at any given point in time. The talent was great. He had rehearsed it enough to actually be able to hand himself a tire that he'd pick up in another take! Still, there was a LOT more work in post to get the moves to work well together.

Also, it used to take a really long time to clean up data. There used to be a lot more noise. On Tribes, we had about 175 moves in the game, total. I've been on shoots later in my career where we got that many A takes in one day!

Newer features, like decent real-time preview have changed the way we execute a shoot. It helps the talent get a feel for the way they are puppetting less than human characters, providing a feedback loop that results in a much better performance. For the mocap team, we love it when we need to align mocap set pieces to objects in our game. Instead of having to take painstaking measurements on set in advance, we can simply move or adjust the set pieces with a few markers on them until they match up to our game assets perfectly.

How much of your final projects include mocap scenes?
Nearly all of the cinematic scenes that have people in them and a majority of the human gameplay animation use mocap in one way or another. There has been a huge effort on this game to get moves exactly the way we need them. The mocap team was working with the gameplay team early on Destiny, to help them quickly prototype the new animation engine. We've helped out with a lot of pre-vis as well.

Are there any recent or notable projects that you can tell us about?
Destiny! It's our newest thing, and we're really excited about it. It's coming out on September 9th, 2014.

Considering that we have only two people at Bungie in Mocap, we're a small team compared to many other studios out there. But, we get a lot done. Rachel and I deliver enough data to keep our animation and cinematic teams happily busy. We love working here, and help make their creative visions a reality. I've been in the games industry for 18 years, and I can honestly say that this is the best place I've worked.

COMBINING A FASCINATING SPORT WITH INCREDIBLE TECHNOLOGY

BASEL UNIVERSITY

Alpine Skiing is a fascinating outdoor sport. Therefore, it is not surprising that persons with total joint replacements, for example a hip or knee arthroplasty, do not want to give up this sport.

BY BEAT GÖPFERT
TECHNICAL DIRECTOR

Medical doctors are warning not to ski with total joint replacements for two reasons: one is the risk of falling and having a fracture near the implant; the other is the high impact loading on the implant during skiing, caused by vibrations, bumps, or sharp turns. Over the last two decades, skiing has changed a lot; the carving ski technique was developed, artificial snow is widely used, and the equipment for the preparation of the slopes and transportation for the skiers has become much more efficient. Skiing is quite often "a rhythmic gliding down a smooth carpet" experience, which makes it easier and therefore more attractive for people with a total joint replacement.

The Project – from idea to data collection
During a tropical evening at a pre-Olympic sport medicine congress in Hong Kong, discussing issues about skiing and Anterior Cruciate Ligament (ACL) functions, we decided to perform biomechanical measurements while skiing with a total knee joint replacement. Within the planning of the study, technical details were discussed with our Vicon representative, prophysics in Zürich, who offered excellent advice. Finally, everything was set and the ethical committee approved the study protocol. At the end of May 2011, we began conducting our measurements on an indoor slope in Neuss in the Lower Rhine region in north-western Germany. The stable conditions of an indoor slope guaranteed comparable results over the whole test duration for the five total knee arthroplasty and ten control subjects. The size of the indoor slope allowed two symmetrical eight gate slalom courses with either a right or a left turn within the measurement volume of the six MX13 cameras. The cameras were placed on a tripod in an insulating styrofoam box to protect them against the minus 5° Celsius cold air during a 12 hour measurement day. Overnight, the whole system had to be removed, as the snowmaking machines were running and the slopes were groomed. The structure of the whole indoor slope with the short distance between slope, chair lift, and preparation room was a big benefit and made it possible to collect a trial every five minutes during one session.

Within four days, we collected over 200 runs, measuring the kinematics with the Plug-in-gait full-body marker setup with 25 mm markers and the surface electromyogram of 14 muscles on both legs.

The data analysis, especially the tracking of the markers, took a lot of time, even using 25 mm markers, sampling at 240 frames per second and measuring indoor with artificial subdued light. Even with our best efforts of controlling the motion capture volume, the area was open to the public and therefore noise from passers by caused us more than normal data control issues! After two years of work, in August 2013, the first Bachelor Thesis in Physiotherapy, and in October 2013 the first Master Thesis in Sport Performance Analysis, was finished. The detailed data analysis and the writing of additional publications are still on-going.

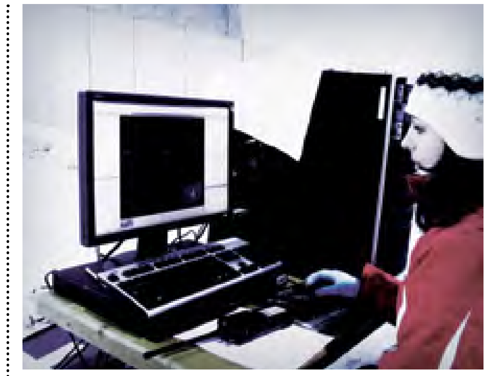


Image courtesy of
Basel University

First Results
The results of the Physiotherapy Thesis (Friedli S. & Schreiber N. 2013) showed that skiing with a total knee arthroplasty changes the muscle activation pattern. Some of the reasons could be that the proprioception of the operated knee joint can be changed and some of the missing sensory feedback may be compensated with a longer and continued muscular activation of the thigh muscles. Furthermore, total knee arthroplasty subjects were skiing with a more extended knee joint than the ones of the control group. The conclusion is that gentle skiing for a fit person with a total joint arthroplasty is possible; as results of Colwell (2010) show, gentle skiing leads to joint loadings of just 1.5 body weight (BW), which is less than walking to the skilift with 2.2 BW. The results of the Sport Performance Thesis (Friedrich L. 2013) showed that even performing the same general movement within a defined setup, the muscular activation pattern varies largely within the control subjects. By using the Wavelet-Analysis-Tool in the new prophysics ProEMG software, some subjects showed a low continual muscular activation over the whole turn, now called an endurance muscular activation strategy. Other subjects had short and high muscular activations at specific moments during the turn, called a crisp muscular activation strategy. To understand the reasons for these two strategies, we might have to collect more data. Next time we would try to use more cameras, a synchronised video reference camera from Vicon for an overview picture during the whole trial, and maybe try to develop a protection system against snow debris for markers mounted on the ski. Furthermore, it would be great to have a small 3-dimensional force sensor between the skiboot and the binding.

The results of this project may contribute a tiny bit to the understanding of the interaction between kinematics and muscular activation in alpine skiing, especially in the knowledge of eccentric muscle work while skiing.

Acknowledgment:
We thank the Laboratory for Movement Analysis of the University Children's Hospital of Basel (UKBB) for providing the Vicon MX System, the Orthopaedic Department of the University Hospital Basel for supplying the Datalogger of the EMG System, Stöckli Outdoor Sports AG for providing the skis, the WSL Institute for Snow and Avalanche Research SLF supporting the measurements with Video Cameras and manpower, and the Skihalle Neuss for blocking a part of the indoor slope over 4 days. A special thanks goes to all subjects participating in the study.

Within four days, we collected over 200 runs, measuring the kinematics with the Plug-in-gait full-body marker setup with 25 mm markers and the surface electromyogram of 14 muscles on both legs.

Images courtesy of
Basel University

CAPTURING INTERACTION BETWEEN HUMAN AND ANIMAL

UNIVERSITY OF BRADFORD

Animals are a big part of our world and feature heavily in our creative works. Multiple horses for example, recently took centre stage in the major role of Joey, an English plough horse in Steven Spielberg's War Horse.

Image courtesy of Sabrina Steinert

BY KARL ABSON
LECTURER IN CREATIVE TECHNOLOGY

In many cases it is not possible to simply use a real animal in film production and as such their essence must be captured and re-created digitally.

Traditionally, gathering of reference material such as photographs and video has been the standard approach. This has led to CG hero characters which fool the audience completely. This is not however the case one hundred percent of the time. Even with high quality reference material, it is possible for even seasoned animators to produce results which are untrue to the animal's abilities.

Overcoming the uncanny valley requires knowledge of both the subject and the techniques used to recreate it digitally. Without such a synergy of knowledge a true to life performance cannot be assured.

Our work at the University is an attempt to build an animal friendly, humane approach which is also cost effective. Working with animals can be difficult and dangerous; the animal does not know the difference between visual effects pyrotechnics and that of a real explosion which has danger. Motion capture is an ideal solution to controlling the environment, especially since the development of outdoor capable cameras.

Working with motion capture and animals proved to be an exciting combination. The early part of our study involved studying horse anatomy and movement. We painted Guiness, a horse belonging to one of our team members. Through this fun process we were able to build an anatomically correct approximation of the skeleton, decide on marker placement and observe and address possible problems such as skin sliding.

Capture in terms of our study involved moving equipment to the subject in question and creating an environment which closely resembled normality. Animals such as horses are prey animals and their first reaction to anything unfamiliar is to run. Through psychology, however, we can find a solution to this problem. Our horse, Marie, was encouraged to investigate the equipment before shooting. After introducing the equipment she quickly developed a liking to the Vicon cameras!

Motion capture is an ideal solution to controlling the environment, especially since the development of outdoor capable cameras.

Image courtesy of Bradford University

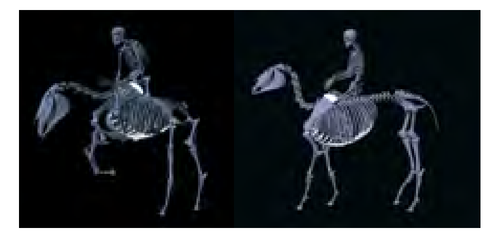


Image courtesy of Bradford University

Our experience of working with the equipment was extremely positive. System setup was completed in no time at all and capture took place without incident. This was despite six meters worth of snow and the cold temperatures found on location.

We captured many great takes and when applied to the model we had created, this delivered an amazing level of detail. Blade 2 also gave us a great experience. It was possible to acquire solved data with minimal manual intervention even in real time conditions. Many smiles could be found in the office the first time our CG horse crossed the screen.

Going forward, we are working with Vicon to make our model and data available to the community. We aim to continue this work to benefit both our students and the wider industry. The University is very much focused on good employability and many of our teaching staff are actively working on real world problems and creating solutions. From the students' point of view, this is important, as standing out through up-to-date skills and show-reels is a first priority. The University holds an up-to-date 16 camera motion capture studio and regularly works with Vicon and motion capture studios around the world. Students use this facility both in and out of taught modules and actively receive hands-on experience with the equipment to capture movement for games, animated and visual effects works. Our research actively informs teaching to ensure students learn the most up-to-date skills applicable to the world they will move into. Students also see real world examples to help give context to the tools they are learning and how they should be applied correctly.

Learning tools in the classroom is a good starting point; however students must be able to apply them in new exciting ways. Innovative research projects are the opportunity to learn such things. How do you attach motion capture markers to a horse? This study gave an opportunity to answer such questions, useful for later employment, as well as practical experience, carrying out day-to-day tasks such as setting up equipment. The result is a student with practical skills but who can actively think creatively to solve problems.

THE EARLY YEARS

BY PROF. MIKE WHITTLE

Long before Vicon became a commercial product, the analysis of body movement was achieved using ciné film, each frame of film being hand-digitised on an analyzing projector - an effective but mind-numbingly slow procedure! The use of television for this purpose was pioneered by David Winter, at Waterloo in Canada, in 1972. However, his system had a fairly low resolution, and was only two-dimensional, as it used a single camera. The markers were half ping-pong balls, stuck on to the skin!

A much more practical system was developed by Mick Jarrett in 1976, as a PhD project in the University of Strathclyde, Scotland. Brian Andrews further developed this system, and used it to make simultaneous measurements from the front and side of his subjects.

A tripartite agreement led to a further redesign in 1979, one system being produced for each of three universities: Strathclyde, Dundee and Oxford. Malcolm Herring designed the four large circuit boards, which fitted into a DEC PDP 11/45 minicomputer. The assembly and testing of the first system was done at the University of Oxford, in the Oxford Orthopaedic Engineering Centre (OOEC), where I had recently started work. I spent three weeks soldering the components onto the boards - an unusual occupation for a doctor! I am proud to say that there wasn't a single 'dry joint', and I was told that if the medical research thing didn't work out, I could always get a job doing soldering!

We used retro-reflective markers, larger but otherwise similar to the ones in use today, but rapidly discovered that using floodlights to illuminate them wasn't going to work. A moving marker 'smeared' its image, becoming dimmer than a stationary one, so that it dropped below the detection threshold and disappeared. We were unable to find a commercially available strobe light which could be synchronised to the television framescan, so Alan Turner-Smith designed and built some visible-light strobes (Fig 1). These worked well, and didn't appear to bother the subjects, although they made a rather loud buzzing noise!

From the outset, we aimed to produce a true three-dimensional (3-D) system, in contrast to the biplanar system used in Strathclyde. We used 'direct linear transformation' (DLT), an open-source computer program for 3-D calibration and reconstruction. The calibration object was a large steel frame with markers on it, mounted on wheels which could be retracted, to lower it onto pads in the floor, permitting registration with our two force platforms (Fig 2). I borrowed a theodolite from the geography department to measure the 3-D locations of the markers on the frame.

One of the first studies we did was to compare the gait of overground walking with that of walking on a treadmill (Fig 3). We found some interesting differences, which were reported at a meeting in Canada.

The system was undeniably 'clunky', but it worked well enough to perform a few research studies, with a particular emphasis on sagittal plane knee moments, and also to perform some clinical gait analysis. We started using the system with two cameras, soon progressing to three.

Realising that it had potential, Julian Morris, who had previously worked at OOEC, developed a commercial version of the system in 1984, and named it 'Vicon'. It was initially produced by a division of Oxford Instruments Ltd. In the university, we were lucky enough to get some government 'end of year' money, and purchased one of the first Vicon systems, which ran on a DEC PDP 11/23 minicomputer. We did some good work with this, although we found that the calibration scheme which shipped with it was not as accurate as the DLT, so we stayed with that. We also increased the number of cameras to four.

We continued using this system until I moved to the University of Tennessee in 1989. There, I developed a gait laboratory using the latest Vicon equipment, which has since been updated from time to time. I retired in 2005, but the laboratory continues to be used for clinical and research studies by my successor, David Levine.

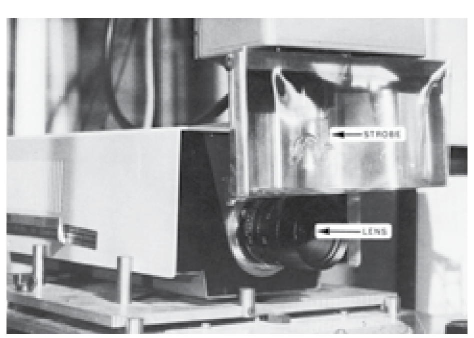


FIG 1
Strobe light, television camera and lens

FIG 2
Steel frame with calibration markers (shown by arrows)

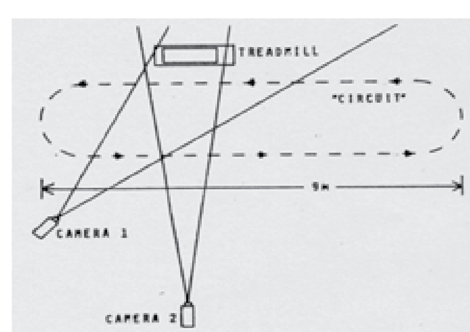


FIG 3
Setup for comparing overground and treadmill walking

SEEING AND HEARING MOTION

UNIVERSITY OF LEEDS

BY DR. KIA NG
DIRECTOR AND CO-FOUNDER OF THE INTERDISCIPLINARY CENTRE FOR SCIENTIFIC RESEARCH IN MUSIC

Musicians often use mirrors to study themselves practicing. More recently we have seen the increased use of video recording in music education as a practice and teaching tool. For the purpose of analyzing a performance, these tools are not ideal since they offer a limited 2D perspective view. Using 3D motion capture technology, it is possible to overcome this limitation by visualizing the instrument and the performer in a 3D environment. Visualization such as this can serve as a "3D Augmented Mirror" to help students improve their technique and develop self-awareness. It assists teachers to identify and explain problems to students.

By analyzing and processing 3D motion capture data it is possible to obtain comprehensive information about a performance. For example, in the case of a string player, we can analyze the different characteristics of bow movements and the relationships between the bow, the instrument and the body. This information can be extremely useful for both student and teacher. It can be used in real time to provide instantaneous feedback about the performance and may also be used to make recordings for in-depth study after the performance has taken place.

Learning to play an instrument is a physical activity. If a student develops a bad posture early on this can be potentially damaging later in his/her musical career. Gestural playing style and techniques also have huge impact on musical expression and expressivity, and represent a type of intangible heritage that challenges recording and preservation approaches. In these contexts, the Interdisciplinary Centre for Scientific Research in Music (ICSRiM, www.icsrim.org.uk), University of Leeds, has been exploring a range of technology-enhanced tools with 3D motion analysis to: (i) support learning and teaching by raising awareness of body posture and performance gesture, and (ii) investigate musical gesture preservation issues. Focusing on performing arts, our musical gesture research interests include: musical instrument performance, conducting, virtual/augmented interfaces, and others.

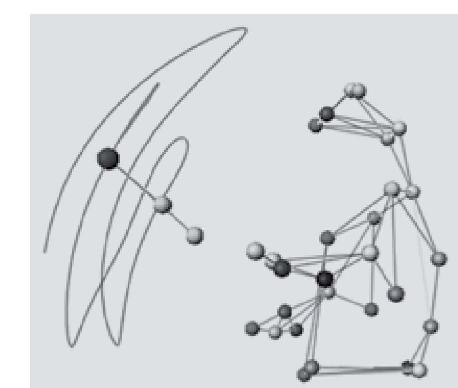
Information about gesture and posture can be communicated to the users in different ways. It may be visualized, through graphical representation, or alternatively, it may be sonified, by mapping selected gestural features to audio. Sonification can be useful in instrumental training for a number of reasons. For example, when a musician is practicing they may not be able to utilize a visual display, since they need to concentrate on the score. The ear may, in some cases, be more suitable for studying gesture and posture, since it can recognise qualities such as periodicity and speed better than the eye.

At ICSRiM, we have been using a 12-camera Vicon system for several large-scale collaborative projects including the i-Maestro EC IST FP6 project on technology-enhanced education, and CASPAR EC IST FP6 project on digital preservation. i-Maestro was a collaborative research project co-funded by the European Commission with partners from five European countries and coordinated by Dr. Kia Ng. The project covers both musical theory and practice issues, driven by pedagogical requirements and analysis, with interactive multimedia technologies. i-Maesto has been one of the key research projects that explored 3D motion in the context of musical performance, developed software tools such as the 3D Augmented Mirror (AMIR) to support gesture and posture in music practice training. AMIR can be used to capture and analyze a performance in detail and has a range of features to assist both teachers and students in numerous ways.

Discover More
Dr. Kia Ng's website:
www.kcng.org

Dr. Kia C. Ng
BSc (Hons), PhD, FBCS, FRSA, FIoD, CITP, CEng, CSci

Dr. Kia Ng is a senior lecturer at the University of Leeds where he is Director and Co-Founder of the Interdisciplinary Centre for Scientific Research in Music (ICSRiM). Kia's research, links together work in the School of Computing and the School of Music on interactive multimedia, computer vision, computer music and AI.



Images courtesy of Dr. Kia Ng, University of Leeds

IT'S NOT ALL DRONES AND LAWNMOWER MEN

VICON

From the very outset of the company's history, engineering applications have been part of Vicon's business.

BY WARREN LESTER
PRODUCT MANAGER - ENGINEERING

In the beginning, customers' use of movement analysis or motion capture for engineering was very few and far between, but each application of the technology was very interesting and helped bring the customer's research to the fore. Be that for tracking crash test dummies, astronauts, or indeed drivers getting into and out of vehicles, Vicon plays a part in the way a large variety of day-to-day products and technologies have evolved in the last 30 years to where they are today.

One of the earliest of such systems was one used by MIRA (Motor Industry Research Association) in 1987/8. The focus of this research was to assess the performance of different types of Anthropomorphic Test Devices (ATD), different types of seats and varying seat belt geometries. It captured points on the ATD at 200 frames per second with only three cameras. Before that, crash test research had been largely qualitative.

With the exception of these early adopters, it was not until the late '90s and early '00s that the use of motion capture for engineering applications really started, as the requirement for real-time streaming of 3D data became necessary. The most common application was in the field of human factors and ergonomics, in particular with vehicle manufacturers studying ingress and egress from cars. Automotive and Aerospace customers were also starting to look at the process, engineering and maintenance of their products. It was at this time, in 2002 that Pratt and Whitney started using motion capture to improve and validate engine maintenance. This was really the first of many Virtual Reality type applications using Vicon. It enabled the user to become immersed within the CAD model and allowed them to undertake various maintenance tasks which helped with the evaluation of the design without having to build physical prototypes. A slew of similar applications followed as the popularity of Virtual Reality increased. However, due to several factors – both related to the tracking and factors beyond our control, such as the quality of graphics and the performance of head-mounted displays, Virtual Reality at this time did not really live up to the expectations that were portrayed in movies, even those from the previous decade such as The Lawnmower Man. Even 10 years after the advent of the CAVE at the University of Illinois in 1995, VR was failing to obtain significant traction in areas other than academic research.

Only now, with the proliferation of consumer grade VR equipment and powerful graphics cards and PCs, is VR, once again, coming to the fore. People are starting to believe that VR will become a technology that is used within everyday life sometime this year or next.

In contrast, with the application of motion capture within ergonomics – where models and methods have not significantly changed since their introduction in Jack, Safework and Delmia since the '80s and '90s, Virtual Reality has over the past 12 years shown massive changes. This is mainly due to the technology that facilitates it with ubiquitous powerful graphics cards, high resolution mobile displays and DLP or LED projectors.

Immersive environments as they are more widely known today (VR has a bad name that is only now being shaken off), will continue to evolve at a rate of knots and will become more accessible to a wider group of people for a larger range of applications from manufacturing, architecture and design, through to rehabilitation and serious games for training.

Interestingly, another buzz phrase "Augmented Reality" is starting to have an influence over the manufacturing of products. For instance, some customers are augmenting reality to give manufacturing instructions to workers whilst they are undertaking the assembly of goods on a production line, thereby reducing the training requirement yet increasing effectiveness. This again is an application area that we will see grow outwards from the early adopters in the aerospace and automotive industries into the wider market. Governments are now realising the importance of this; in a post-recession world, manufacturers need to invest in new ways to remain competitive and meet the demand for innovation. For example, in the UK at least two such government initiatives exist: one for research in technologies that help move manufacturers towards zero prototyping; and the second being a mandate to ensure that all publicly funded construction industry is "paperless" by 2016. Both are most definitely supportive of VR and AR technologies.

Another application that we have seen significant growth in over the last decade, is that of robotics research. Robots have a very wide range of applications, not only in manufacturing industries, but also nuclear energy plant construction (and destruction), medicine, "Blue light services" and of course military. Research in biologically inspired robots - biomimetics being the trend du jour in an attempt to understand the motion of biological structures – harking back to the original use of Vicon systems for gait analysis and biomechanics.

This growth will continue, as robots, in whatever form, cannot become part of everyday life until some form of equivalence with their human, animal or manned counterparts is proven and our understanding of their motion is complete. With all this in mind, there are interesting times ahead and the use of tracking or motion capture can only increase within engineering. The next couple of years will be pivotal as we become familiar with products and devices that have been born out of research undertaken in the first 30 years of Vicon's history and, I for one, hope that the next 30 years are just as interesting.

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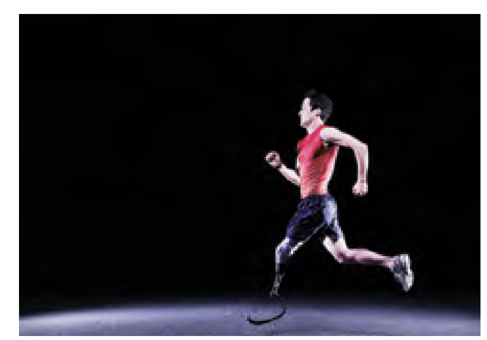


Image courtesy of AWE

VICON MOVES GM DESIGN INTO THE DRIVER'S SEAT

REAL-TIME, 3D AND FULL SIZE

GENERAL MOTORS

BY VICON EDITORIAL TEAM

Getting it right is paramount at General Motors' design studios. A lot depends on putting their engineers and designers in the driver's seat, literally. Capturing and testing exactly what a driver will see and experience is critical to evaluating its automotive product designs.

When Steven Powell, Virtual Reality Studio Manager for GM, was faced with a nearly decade-old inertial tracking system that was showing signs of age, he asked what was new. What was better, faster and could help the team at GM's Virtual Reality Studios do their jobs better? He recognized that gaining a competitive advantage means reducing costs and improving time to market; benefits that a state-of-the-art virtual reality system can help deliver. Easy and affordable, VR can provide the richness of physical prototyping – but only when the quality of interaction between the real and virtual world is intuitive.

After hearing about Vicon's reputation in the market and seeing the Apex system in action, a few demos and conversations was all it took to see the difference it could make within their studio.

Our motion capture technology, backed by the immersive virtual environment provided by RTT, combined for an advanced solution that solved GM's challenges and offered new advantages. The 3D tracking system's capabilities were essential – particularly its quick and easy perspective changes. As we humans are unable to perceive 3D from stereoscopy alone, head tracking is imperative to providing a true immersive experience. Traditional virtual reality set-ups suffer from high latency and poor accuracy, which prevent the required suspension of disbelief for the best results.

"Gone are the days of grabbing the geometry and physically moving it around to change the perspective," said Powell. "Now I can look up at the front of the car and it grabs the hoodline. I can zoom up and rotate to see the sheet metal lines of the hood; it's pretty impressive." The high-resolution visual quality and modular configuration of the display system make it easy to install and configure, and advanced calibration is simpler and faster.

Finally, the Vicon system is virtually plug-and-play, requiring very limited onsite training. The key is for designers and engineers, like the team at GM, to be up and running immediately, intuitively using the system and focusing on design - rather than technology challenges.

> "We had seen a demo of Vicon's optical tracking system at Siggraph and we were intrigued. There are similar systems on the market but few offered the same level of quality and capabilities, and none at the same price point."

SECURING YOUR DREAM JOB IN INDUSTRY

TAKING OPPORTUNITIES WHEN THEY ARISE

THE IMAGINARIUM

BY REBECCA-LOUISE LEYBOURNE
MOTION CAPTURE TRACKER

The last time I was featured in Vicon's The Standard I was quoted as a student at the University of Bradford. Now I am employed in the VFX industry as a Motion Capture Tracker at The Imaginarium Studios, a London based performance capture studio, co-founded by actor/director Andy Serkis and film producer Jonathan Cavendish. With countless amazing experiences and several high profile projects already credited to my CV, I look back at how being able to have practical experience with Bradford University's 16 Vicon T20 system not only inspired my career path but also played an important part in helping me get my first job in industry.

During my time at Bradford I studied an undergraduate degree in BSc Computer Animation and Special Effects, followed up by a MSc in the same field to progress further. Bradford's lecturers, modules and final projects are catered to allow students to graduate with a mixture of industry specific skills, using industry standard software and technology targeted to ultimate career goals.

I took the Motion Capture module in my second year of my undergrad and have never looked back. I knew from the first lesson that this was a technology that I wanted to learn and work with on a daily basis, and I made it my goal from then on to make it happen. After learning the basics of the pipeline, I was then able to use the system as part of my final undergraduate project and finally in my master's year, rearranged the studio for the University's first ever optical facial shoot, in a study of the current techniques of capturing facial animation.

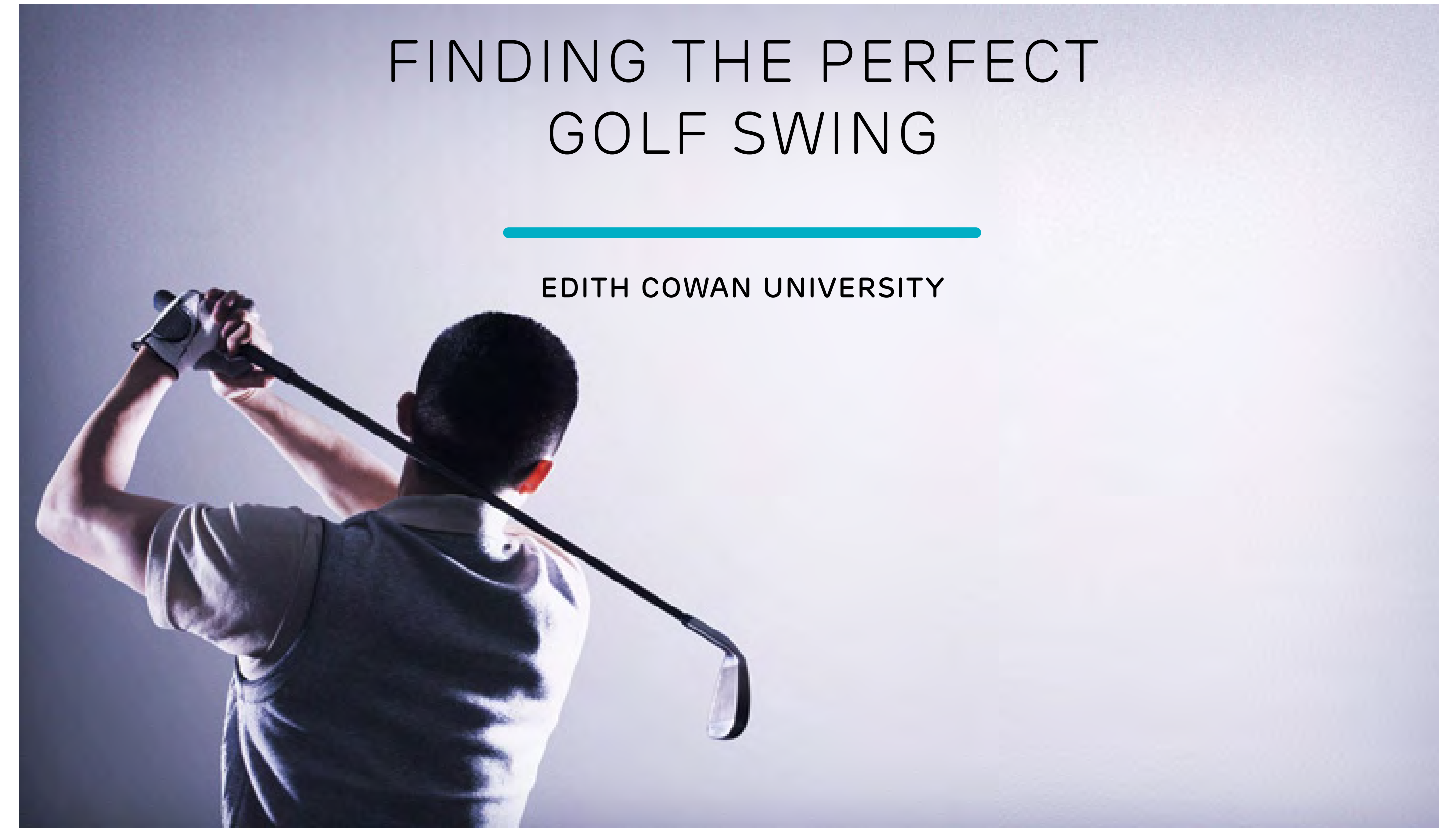
Bradford is one of the few universities in the country to not only have a fully functional motion capture system, but to teach it on a module that allows students to have a hands-on experience in the studio, either as an actor in a suit, or behind the computer capturing data, then to post process and retarget movement onto a character in MotionBuilder. As the industry develops, performance capture is becoming more advanced and allows the next generation of films and games to break new boundaries of realism. Having access and being able to operate a unique technology is a huge benefit to first time applicants trying to get into the industry, proving they can handle the pipeline and be productive right away. Even in other areas of games and animation, I still see so many animation applications, especially in the games industry, with experience of using motion capture data as a desired skillset, so even just testing the waters of the technology may prove to give you an advantage over other applicants. My own experience meant that when I went for my interview at The Imaginarium I had the advantage of already being able to operate the Vicon hardware and software the studio used. As I was lucky enough to be hired, this meant on my first day I was able to assist in the running of the system within a few hours and have now gained experience as a confident systems operator, or with a co-pilot, independently driving the system and capturing data during commercial shoots and R&D. Although during my first few weeks I had to learn the specific pipelines and in-house scripts that The Imaginarium uses on stage and in post, my University experience allowed me to quickly become an efficient part of the capture team, in comparison to those who would need to learn the pipelines from scratch, ultimately reducing my training time and proving me a cost-effective member of staff for the studio. Now, having worked at The Imaginarium Studios for over a year, I still manage to learn something new almost every day, and passion and obsession with the technology I use and now help develop, is still as strong as ever. I still keep in touch with my University, and urge students to take advantage of the opportunity they are being offered by having access to the mocap system and gain studio experience, before taking their first steps into the industry.

Andy Serkis and Actor Chipo Chung at The Imaginarium

My own experience meant that when I went for my interview at The Imaginarium I had the advantage of already being able to operate the Vicon hardware and software the studio used.

FINDING THE PERFECT GOLF SWING

EDITH COWAN UNIVERSITY



BY CHRISTOPHER JOYCE

My PhD consists of five unique studies, which have used Vicon motion analysis to understand the technique (upper body movements) variables in the golf swing, and also equipment variables (driver shaft) to analyse how the golf club performs under dynamic conditions (the golf swing). I'm also a registered provider for the Australian PGA, and work with elite golfers' trainee programs and present the latest research, conditioning and injury prevention methods. The research produced from these studies have been the result of a collaborative research team from the engineering and mathematics schools at Edith Cowan University, and also the involvement of teaching professionals and club-fitters from Royal Fremantle and Lake Karrinyup Country Clubs, in Western Australia.

Previous research into understanding how the upper body moves in the golf swing have modeled the upper body using the shoulders and pelvis only. The first two studies aimed to model the upper body as a multi-trunk segment, which allowed analysis of the "lower trunk". The validated model was then applied to a group of elite male golfers and it was discovered that the lower trunk segment was the largest variable associated with clubhead speed. This supported previous research that the upper trunk should be modeled as a multi-segment model, and it allows a greater understanding of the sequential contribution of each segment in the golf swing.

The third study used the Vicon system to understand the dynamic performance of the golf club during the golf swing. Current methods by golf club-fitters and teaching professionals use static methods which have shown little or no correlation to shot outcomes of the golf ball. Using coordinate data from equi-spaced markers along the club shaft, and mathematical point line algorithms, the deflection or "kick-point" was revealed. This point on the golf shaft was shown to change its position throughout the golf swing, and was different to that reported statically. The results from this study allowed investigation into how the changing of the kick-point altered the launch parameters of the golf ball at the point of impact. Study four revealed that by using the methods of study three, dynamically, the launch parameters of the golf ball were linked to the performance of the golf shaft, which has previously not been investigated. My final PhD study investigated how elite male golfers modified their golf swing pattern when hitting with drivers fitted with different shaft properties (kick-points). The wrist joint was also added to the multi-segment upper body from studies one and two, and differences were found in the swing patterns. Previous research had revealed no changes in swing patterns when using different drivers, although the use of the multi-segment upper body model and the inclusion of an outdoor familiarization protocol may have allowed for differences to be found. The results of this study show that golfers do adapt their swing patterns when using different golf clubs, and also a greater understanding of how elite golfers modify the launch parameters of the golf ball, i.e. launch angle and spin.

The inclusion of a wrist segment for study five was shown to have a large contribution to clubhead speed. It was reported that faster clubhead speed was associated with a more delayed, or "un-cocking" of the wrist in the downswing. It was also reported that the wrist movement patterns (point of release) was shown to be different when using different drivers (high vs low kick-point shafts).

Info
Christopher Joyce is a PhD student at Edith Cowan University.

SMALL STEPS, BIG LEAPS

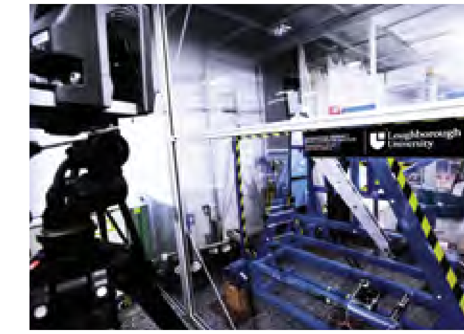
VICON

BY DEREK POTTER
PRODUCT MANAGER - LIFE SCIENCES

Vicon has been at the top of the motion capture business for thirty years now; and that's no small feat. I'm proud to say that I've been working for the company for a decade and I'm amazed at just how much has changed and progressed in the field in this last third.

How cliché would it be to start an article like this by telling you that "In my day, motion capture was a lot harder and required far more work!"? The kind of line that everyone's parents have close at hand. As a child growing up in Canada this story inevitably involves how far one's parents had to walk to school in the snow and cold. FYI, for those not from Canada, this distance was always further than the distance that you were expected to walk. Well, I don't care how cliché it is to say, because it is true. Motion capture was harder when I was in school. I remember long hours in my undergraduate days "hand digitizing" video one frame at a time. Carefully clicking on each landmark before advancing to the next frame and repeating the process. Years later when I was finishing grad school, the field had progressed to a point where the cameras collected continuous data; however to do anything with this information, researchers still needed to write their own bits of processing code. The amount of time spent working on getting to the data was often more than the time spent analysing the data.

The first time I saw a Vicon system working I was astounded at what it could do. Compared to what I had been working with at that time, the time to go from starting collection, to seeing meaningful data in front of you, was drastically reduced. A single word sprung to mind,



"Magic". I think this is what great technology should do. When you're able to see a jump forward, rather than a small step, it should seem like magic. The gait lab that I managed at the time did not have a Vicon system and I couldn't help thinking about how much time it could save the researchers /technicians (myself included). This thought did not come from a sense of laziness, but rather at how much could be accomplished if less time were required to get to the point where outcome assessments or research conclusions could begin. I've tried to carry this thought with me in my current role as a Product Manager at Vicon and had hoped that I would have the opportunity to be part of technology jumping forward, not just stepping forward.

In 2004 I was fortunate enough to join Vicon during a period of rapid development and expansion. The company grew significantly during my first few years, expanding into new markets, new technologies and new territories. This was the year that Vicon first launched our original line of MX cameras. These were the industry's first cameras to utilize fully independent on-board processing. This first was only one of many 'firsts' that I have been able to be a part of during my time with Vicon. 2004 was also the year Vicon launched its flagship application in life sciences – Vicon Nexus. As Nexus matured as a software platform, other firsts followed such as real-time video vector in 2006. Video vector is a wonderful example of a feature that some assessed as showier as opposed to functional. Fast forward to today's world of clinical motion capture and we find that many now consider this an invaluable asset and a standard component of an assessment. Being part of shifts like this is what being part of Vicon is really about and it's why I'm still with the company after ten years.

The life science market that I shepherd was the first market where motion capture technology truly gained traction: clinical assessments of gait patterns for children with conditions like cerebral palsy in hospitals and sport performance research in university biomechanics labs. The life science market is still the largest market for Vicon, comprising more than fifty percent of our annual business. A fact that I (tongue in cheek) occasionally remind my colleagues about. Working in an area that you feel actually provides a benefit to others is tremendously satisfying. Whether this is through the assessment of gait, the furthering of research, or helping athletes train for the Olympics. The entertainment division at Vicon was in full swing by the time I started and I must admit that upon arriving at the company I still considered myself a researcher working in industry. This meant that I was a bit of a snob when it came to applauding the developments in the other markets. As a biomechanist, I was using motion capture for its true purpose and wasn't particularly interested in what those in movies and video games industries were doing, (although when speaking to my friends back home I didn't mind mentioning that my company was responsible for the great VFX in the latest blockbuster movie). Over the past ten years, however, I've been shocked at the number of wonderful benefits that life science has been given through development work in other markets, thus forcing me to re-examine my views. This cross-pollination effect is something that I feel is unique to Vicon and one of the reasons that so much innovation can be produced by what is essentially a relatively small company.

Motion capture is now starting to mature past its adolescent stage, and like most technologies, I see it becoming more ubiquitous. We at Vicon have been witnessing the market slowly expanding into new areas; and this expansion is accelerating. I feel that positive growth will see motion capture start to 'disappear' into the background. What I mean by this, is that mature technology becomes so easy to use that technical 'know how' ceases to be a barrier to its use. This type of progression is something that we've all seen in PCs, smart phones and, more recently, in tablets. This is why a lot of our future focus is aimed at making our software more automatic and intelligent. We have a large number of concepts we think will elevate the technology, by dropping the technical bar. These include, systems that can recognize a degrading calibration and repairs itself automatically, and operations that recognize when a subject enters the volume and auto-calibrates them. I regularly receive feature requests for a feature that "Writes my Thesis" or "Auto-Publishes my Paper". These last two are probably a little further off.....

> "I think this is what great technology should do. When you're able to see a jump forward, rather than a small step, it should seem like magic."

Most technology and software businesses follow a natural cycle that includes research, internal development, new technology platform introductions and platform maturation periods. The cycle then repeats itself. After a significant amount of investment and development, this year is set to be the largest step forward in life science that Vicon has had since my first year with the company. We are going to be making significant steps forward with the launch of the much anticipated Nexus 2.0 platform. It's difficult to express just how excited I am about this introduction, as I truly feel this will be a jump rather than a small step forward for Vicon and our users. I hope you, the Vicon community, are looking forward to this as well.

WORLD RECORDS + AAA TITLES

UNIVERSITY OF PORTSMOUTH

Our first foray into motion capture started in 2005 with a 6 camera V-Cam system. It had been installed by Virtalis as part of our new VR Room and we had no experience in using Vicon hardware or software before that, so a steep learning curve sat ahead of us.

BY ALEX COUNSELL
PRINCIPAL TECHNICIAN FOR THE SCHOOL OF CREATIVE TECHNOLOGIES

We started with the manuals that shipped with the system and then shortly after, Alex Muir a Vicon engineer, came to visit us and showed us how to set up the cameras and use IQ for the first time. As soon as I started learning more about motion capture I realized it was something we had to develop further for our students, and what a great facility it could be.

In 2006 we moved premises, and due to the increased use of the mocap system, we managed to get a larger dedicated room, but still only had our six V-Cams. The locale was less than glamorous, but it was a great start for a mocap studio at Portsmouth University.

Due to the popularity of the facility, it was becoming obvious that one person would not be able to run the studio alone. In 2007 we decided that the best people to run it would be the students themselves, and advertised for our first team. The response from our students was overwhelming and we shortlisted and hired! One of our first student team members, Geoff Samuel, has become one of our most successful students. During his time with us he landed a summer placement in Audiomotion Studios in Oxford. When he graduated, he went to work as a Pipeline Software Developer at MPC, and has recently joined Weta Digital as a Mocap Pipeline Developer and got his first film credit on the Hobbit: Desolation of Smaug.

"Working at the Mocap Studio was an amazing experience, one that helped shape my career into what it is today. The challenges that myself and my student team faced were real-world production problems for clients who were often new to motion capture and working towards tight deadlines. It's this environment, which echoes the production world so well, that prepared me so well for my move into the industry." (Geoff Samuel, Motion Capture Pipeline Developer at Weta Digital and BSc Computer Animation Graduate, 2009)

Over the next couple of years we acquired two more V-Cams and pushed the system to its absolute limit capturing three actors. In 2009 we were awarded funds to upgrade the suite to eight T10 cameras and our first experience with Blade started. In 2010 we moved premises, providing us with a larger volume and we also upgraded the system to 12 T10 cameras, a big move up for us.

With this big change in venue and setup we were able to now offer a much better service to our students, and be able to embed motion capture in our teaching. The first use was in a unit for our BSc Computer Animation course, in which our students design and create characters from scratch and drive them with motion captured data. To allow them to do this, an initial lecture is given about mocap and the studio process. The students are then given a live demo of volume calibration, actor and prop marker setup, ROMs and calibration, and we then show the real-time link between Blade and MotionBuilder driving characters. This also includes a virtual camera rig live in MotionBuidler. We then set up a week where students can come and direct an actor, with a prop, from a shot list that they submit and they are allowed to choose one minute of movement data for their character. We then clean their data and deliver it to them in the format of choice. As the unit regularly has 60 plus students, this week is very busy and the clean-up can take a couple of weeks to process all of the students' data.

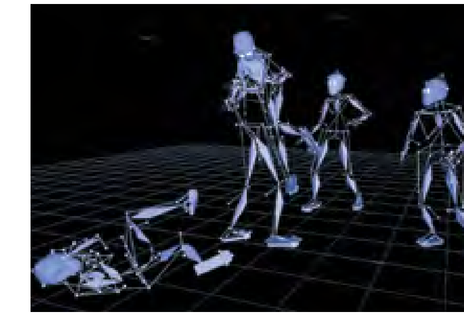
For the first time this academic year, we are delivering a 3rd year unit, where students learn to process motion capture data in Blade, and are assessed on the quality of their tracking and cleanup, plus solving (using the Production Skeleton), exporting, and then retargeting and some basic motion editing in MotionBuilder. The sequence they have to clean, was shot specifically for the unit and consists of two actors performing a sword fight, with varying stages of ranged and close interaction, lasting around a minute and a half. We used professional stage combat actors from Captivate Ltd.

We have learnt so much from running our studio for the last nine years, and aside from teaching, we needed an in-house project to push our ability to its limit. This is where the Stina & the Wolf project came in.

In 2011 one of our lecturers, Paul Charisse, came to me with the idea of making a feature length CGI film at the university, using students and staff to create a 'AAA' quality film, similar to the likes of Avatar and Tin Tin. It was decided that we would use motion capture to drive the characters, including facial capture.

Once I had read the screenplay, the job of building a custom mocap stage began. We quickly realized that the 12 cameras that we had would not be able to cope with the size of the new volume and the number of actors we intended to shoot. Vicon helped us with eight additional T160 cameras to

Motion capture set-up at Portsmouth University



Mocap data from Vicon Blade.
Image courtesy of Portsmouth University

add to our system, totalling 20 cameras, and over the course of two weeks, the stage was built, including custom facial cameras, sets and props.

One of the more tricky aspects of the film was its setting in the Carpathian Mountains, so we had to devise a way of capturing our actors on varying inclines during their performances. We designed a series of adjustable ramps that would achieve this, which could be set up and reconfigured quickly between shots. They were used for mountainsides, underground caverns and even the rock face of a waterfall for our actors to climb up.

Some other sets included the interior of Stina's house with a front door, cooker, dining table and mantelpiece, there were forests, watchtowers and even a fairground. All layouts were designed before the shoot, and all actors marks were placed using tape. A quick turnaround was also required between the shots, so our team of student volunteers practiced the set changes during our rehearsals. These lasted two weeks and gave the actors time to get used to the suits, head cams, set layouts and props to ensure that the real shoot went as smoothly as possible.

On August 2nd 2011, the shoot began, and over the course of the next five weeks the entirety of the screenplay was shot. We shot every day from 10am until 5pm, capturing a maximum of 6 actors at once, including using four of our homemade headcams.

Every take included on set audio, two reference cameras and up to 4 streams of facial video. At the end of each day, all of the takes were set up for batch processing, so we could review first thing in the morning while the actors were preparing. This way if we needed any re-shoots we could schedule them in. During the shoot, we had some VIPs on set...Vicon's own Bob Dimmock and Adele Burdock came to add words of wisdom and support (plus to make sure we were doing everything correctly!).

One of the highlights of the shoot was setting a new world record! Our Actor Martin Daniels, who is playing the Pipe Catcher character in the film, was, at 74, recognized as the oldest man ever motion captured. This was not adjudicated by Guinness unfortunately, but by Demian Gordon of the Motion Capture Society. Martin now has his picture in their world record section!

There was only one injury during the shoot; one of our actresses tripped in the dressing room, and managed to dislocate her thumb in two places! Not even on set. No mocap shoot would be complete without a wealth of broken markers, plus roll upon roll of gaffa tape, numerous bottles of super glue, and enough shoe deodorant to run a bowling alley!

Since the shoot, we have developed a robust pipeline to get the data onto our character rigs. All cleaning and solving is done in Blade, then exported via FBX to MotionBuilder for some scale adjustments and motion editing (if required). There is no retargeting required as all of our actors have digital doubles so far. Then the final FBX motions are imported into Softimage where a script fits our enveloped rigs to the data, and attaches a complex facial rig and hand system for our animators to push through to final.

Discover More
Project trailer:
vimeo.com/83482109
www.stinaandthewolf.net

A COUPLE OF ANNIVERSARIES

VICON

Digital Frontier is one of Asia's largest motion capture studios.

BY ALEX MUIR
ASIA PACIFIC SALES MANAGER

In March 2004, I started what has become my 10 year journey with Vicon. Beginning in the Oxford office, and moving on to open our first office in the Asia Pacific region eight years ago. This 30th birthday edition of The Standard is a great place to look back at the success and growth of Vicon in this region.

Advances in Life Science
Our most established market in this region is biomechanics and gait, and we continue to see this market grow. For example in Thailand, we have grown from one customer, Mahidol University, to four universities and hospitals offering clinical gait services throughout the country. In Japan, the Saga University Hospital has 14 Vicon cameras and 25 force platforms; they need to deliver the gait analysis report in 15 minutes and 25 force platforms means they always get good foot strikes!

We have also seen Asia's top sporting companies adopt and expand their Vicon motion capture systems: in Japan, Asics, Wacoal, and Fujikura, and in China, ANTA Sports, Qiaodan Sports and Li Ning. And they're not just capturing the usual sports like Basketball and running - the Australian Institute of Sport completed a study on the sport of Racewalking!

Real-Time Expansion in Entertainment
The last 10 years have seen some great advances in gaming, and motion capture has had to keep up with that progress. We have seen several Japanese customers purchase 100 cameras and our first big Chinese games company, Snail Games, purchased in 2013.

Our customers include Digital Frontier, Konami, Sega and Square Enix. Consoles are banned in China so most of the gaming is PC based. The advances in motion capture have meant that Animal Logic (Australia) was able to drive a virtual talk show host in real-time and Next Media Animation (Taiwan) was able to produce animations of the days' news stories for their customers to watch on their homeward commute.

Engineering for automation
Ford Australia is using a Vicon system to virtually design a vehicle. They are not only able to check the aesthetics, but can understand the different vehicle systems without having to build the physical car.

The unmanned aerial vehicle (UAV) capture application didn't exist 10 years ago. Today, we have many customers, like Chiba University (Japan) who are researching the best way to fly into the Fukushima Nuclear Zone to conduct experiments and measure radiation using UAVs. Another customer, DJI Innovations (China), is bringing UAV technology to the consumer with their Phantom Series UAVs. Expect to see one flying above you soon! UAV technology isn't only robotics; researchers at Nanyang Technological University (Singapore) are using intelligent systems and Vicon to measure and control the flight of Rhinoceros Beetles.

The last 10 years have seen some great advances in motion capture technology and the applications our customers have been developing. I can't wait to see what the next 10 years bring.

VICON BOLSTERS COMMITMENT TO CUSTOMERS IN LATIN AMERICA

VICON

Vicon has enjoyed a long and successful history in Latin America. Our presence in the region began with gait analysis systems in Brazil in the mid-1990s.

BY AMY AUGUST
SALES ENGINEER, LATIN AMERICA

Today, it has expanded to include systems in 13 countries throughout Latin America and the Caribbean, spanning all three of Vicon's major markets.

Research in biomechanics, sports science and kinesiology, is an area where the use of motion capture is rapidly expanding. Vicon currently boasts over 40 life science research customers in the Latin America region. After the very successful hosting of the International Society of Biomechanics (ISB) conference in Natal, Brazil in 2013, and with both the Olympics and World Cup coming to Brazil in the next few years, Vicon expect to see great advancements in the life sciences fields in Brazil and surrounding countries over the next five years.

The visual effects market has also seen great growth over the past few years. There are currently more than 10 animation related systems operating in Mexico alone, ranging in applications from teaching tools at the Universidad del Valle de Mexico to professional studios like Gyroscopic in Guadalajara.

All of this amazing growth would not have been possible without Vicon´s dedicated group of distributors and partners in the Latin American region. For a list of current resellers and more information, please visit the Vicon website at vicon.com or contact me directly **amy.august@Vicon.com.**

CASE STUDIES

Wagner de Gadoy, formerly of the AACD clinic is Sao Paulo and currently working with the Albert Einstein Hospital in the same city, noted that his first Vicon system, a 370 Workstation in the 1990s "Proved to be extremely robust. The continuous aid of Vicon's support service was essential for the development of gait analysis as [an] indispensable instrument in the rehabilitation processes." This early success helped lead to the choice of purchasing a new Vicon MXF40 system at the Albert Einstein Movement Laboratory in 2008 that is still functioning today.

The MOVISYS laboratory run by Dr. Camilo Turriago in Bogotá Colombia has an eight camera T40S system, which was installed in 2010. The lab currently processes between 15-25 patients weekly from across Colombia and neighboring countries.

The Vicon Polygon program is used to create a custom gait report for each patient. Between three-five patients have their gait data captured every morning in the lab and, thanks to the ease of use of the Vicon system and the clean data provided, all of the patients´ data are processed each afternoon so that the doctor can expect the new batch of Polygon reports on his desk every evening.

The Universidade Federal de Santa Catarina was the first to implement a Vicon motion capture system in Brazil for VFX education, while the newest animation centric system at Universidad Federal de Gioas boasts 32 of the four megapixel T40S cameras with three of the new Cara facial capture units.

A BRIEF HISTORY OF VICON

Becoming a global leader in the field of motion capture doesn't happen overnight. Since the early 1980s, all the brilliant people who work with us have had an impact on the award winning systems you use today.

Vicon has won many awards over the years, and we're proud of them all. CG World Innovation Award 2000; The Queen's Award for Enterprise 2001; Scientific and Technical Academy Award ® 2002; iF Product Design Award 2008; and Best New Product at the BCS and Computing Awards 2009.

Early 1980s

First Vicon RSX system installed at University of West Virginia, USA

Vicon opens US office to support growing number of North American customers

1985

First Vicon system installed in Japan at Saitama Rehabilitation Center, Tokyo

Second generation Vicon system launched – Vicon VX

1990

Newington Children's Hospital become first US Clinical Gait Analysis customer

Seven camera Vicon 370 launched with 50/60fps 525/625 line cameras

First Windows 3.1 software, Vicon Clinical Manager, introduced

200fps 500 line motion capture camera introduced

Vicon 370E launched for use in game development and film production with choice of four camera types

1995

House of Moves use Vicon 370E system to capture ground-breaking VFX in Titanic

Vicon expands US office to support growing animation market

Vicon DynaCal large volume dynamic calibration system introduced

24 camera Vicon 8 introduced – the world's first mocap system developed just for animation

Launch of the world's first one megapixel motion capture camera, the Vicon MCam

2000

Vicon becomes subsidiary of OMG plc, as company IPOs on London Stock Exchange

Sony Pictures Imageworks is the world's first studio to use over 200 Vicon cameras for the Monster House movie project

2005

Launch of the world's first four megapixel motion capture camera, the MX40

Vicon develops the world's first custom-built motion capture sensor, the Vicon Vegas

Launch of the world's first 16 megapixel motion capture camera, the T160

Launch of the Bonita 0.3 megapixel motion capture camera

2010

Bonita 1.0 megapixel camera expands the Bonita camera range

Launch of Bonita video cameras – first reference video camera designed specifically for motion capture

Cara is launched as the first out-of-the-box 3D facial motion capture system.

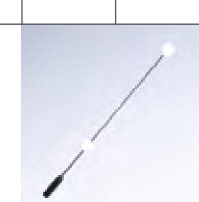
2015

Vicon celebrates 30 years of pioneering motion capture

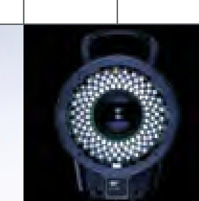
Vicon RSX

Vicon VX

Vicon 370E



DynaCal

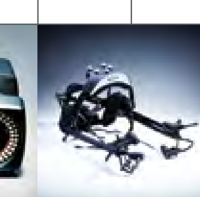


Vicon MCam

MX40

T160

Bonita



Cara

Vicon 30

Image courtesy of Satish Shewhorak featuring deformed Softimage character models

GAIT ANALYSIS BRINGING DIVERSE VIRTUAL CHARACTERS TO LIFE

TEESSIDE UNIVERSITY

To improve the believability of diverse virtual characters' appearance and locomotion, a solution is being sought at the intersection between life sciences and digital entertainment.

BY SATISH SHEWHORAK

Current research shows that it is already possible to create procedurally differentiated characters of varying body shape and walking style.

This is important as audiences are capable of detecting cloned characters that break their suspension of disbelief. The problem that still exists is that there is little research in how to relate motion diversification to appearance diversification.

My PhD research looks to not only improve the diversity of characters' motions but also their believability in relation to their related body morphology.

Whilst there is research published on how to create configurable and diverse locomotion using inverse kinematics and spacetime optimization, these physical simulations can lack the rich detail and nuance of actual motion captured walks. For that reason I decided to use motion capture as the basis of my research.

I aimed to analyse the walks of people of increasing body fat percentage, identify prominent changing aspects of gait and to reapply it to a lean virtual character to make him walk like an obese character. To understand the relationship between appearance and walking style, I measured participants' body fat percentages using an InBody720 bioelectrical impedance machine. Weight was recorded using standard scales and nine other body metrics were measured using a tape measure against structural landmarks in consultation with ISAK certified sports science technicians. From this I could also derive comparative metrics such as Waist-to-Hip Ratios and BMI levels.

I then took the participants through the motion capture process. Whilst a compression suit was suitable for the leaner participants, for heavier set people this became more of a challenge. For those that could squeeze into the suit, some found that it made them walk uncomfortably or self-consciously. Other participants simply could not fit the suit and marker tape fixed to loose clothing could also feel restrictive. I requested that participants bring gym gear or any tight fitting clothes that they feel comfortable switching to. A combination of on-skin marker placement, and light but firm marker tape over clothes, became an effective application of the validated Vicon Plugin Gait Marker Set, maintaining comfortable movement whilst reducing marker sliding.

Participants were then asked to walk at five increasing but self-selected speeds and a fixed 1.2m/s, whereupon any occlusions, typically at the waist, were cleaned up.

Vicon Nexus allowed me to export not only the absolute positional data of each marker but to also export the local rotational data of each interpreted limb. From here I could perform gait analysis on changes in position and magnitude of eight variables over increasing body fat percentages. This provided regression formulas that could then be reapplied as part of a virtual character modifier. This scripted mechanism was developed within Softimage using JavaScript with the first aspect featuring an appearance deformer. Using reference photography and standard shape deformation tools, I increased the appearance of a lean character to that of an obese person. Using the locomotion trendlines I had previously analysed and hypothesised, I then scripted motion modifiers to exaggerate fourteen gait variables of the lean walk to appear obese.

As the first sample set was limited, I have been deploying perceptual surveys to determine the most dominant gait variables to focus future analysis and application to, however early results appear promising.

The research project is a result of the James Caldwell Scholarship, provided by a former Professor at Teesside University. My research is being supervised by Dr. Wen Tang and Dr. Fred Charles within the School of Computing which has its own motion capture lab used for games and animation students. However as my research represents an intersection across digital entertainment and life science interests, the School of Social Sciences & Law have also generously allowed my use of their Biomechanics Lab which has a six-camera Vicon System 370 better suited for my purposes. Not only can the Vicon System, capture at a frame rate four times higher, but importantly it allows the exporting of rotational limb data and an efficient retargeting solution to virtual characters within MotionBuilder.

As my PhD research draws to a close in 2014, I am conducting a second, larger round of data collection as this will undoubtedly provide a richer, more detailed gait analysis to apply to my appearance and motion modifier. Ultimately, I will test whether the obesity related gait variables I have analysed and replicated are perceptually believable when applied to an obese character. This could then prove to be a useful tool for animators with only a single character and motion captured walk to believably create a crowd of diverse looking and moving characters. Beyond the scope of my research I would also be interested in capturing, analysing and modifying walks of other demographics such as women, older members of public and people from different ethnic backgrounds.

Info
Satish Shewhorak is a PhD candidate at Teesside University, and the first recipient of the James Caldwell Scholarship.

OXFORD GAIT LABORATORY UPGRADE TO FIFTH VICON SYSTEM

The Oxford Gait Lab recently upgraded its existing Vicon motion capture system to a T-Series system with Bonita Video cameras.

BY VICON EDITORIAL TEAM

Based at the Nuffield Orthopaedic Centre (Oxford University Hospitals NHS Trust), it was one of Vicon's first customers, originally using the system for research purposes in the early '80s and going on to offer a gait analysis service from 1996.

The Oxford Gait Lab sees an average of 400 patients a year and is currently setting up a new clinical service for upper limb motion analysis, which will analyze children with Hemiplegic Cerebral Palsy and Brachial Plexus Palsy. The Oxford Gait Lab also uses their Vicon system for teaching and research purposes.

"Upgrading our system meant that we could capture more markers over a larger area, effectively increasing the length of our capture area. This means the patient isn't required to do as many trials, which is really important for patients with limitations in their walking,' said Dr. Julie Stebbins, Clinical Scientist and Operational Lead for the service.

"Not only that, the data quality from both T-Series and Bonita Video is improved, compared to previous cameras," Stebbins continued.

As well as increased capture volume and improved data quality, the system upgrade will enable the new upper limb service to have a more efficient and flexible method for capturing data.

"The fact the Oxford Gait Lab has been a customer for 30 years is testament to the quality and technological advancements of Vicon products over the years. We have a great working relationship with the team and look forward to seeing the successful launch of the new Upper Limb Clinic."
Imogen Moorhouse, CEO, Vicon.

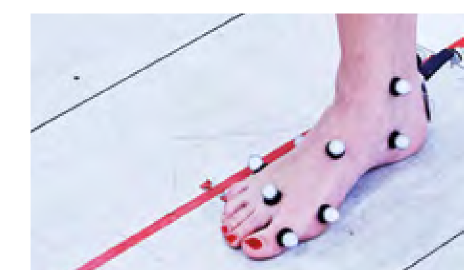


Image courtesy of Nuffield Othorpaedic Centre

QUE VIVA

MOTION CAPTURE!

UNIVERSIDAD DEL VALLE DE MEXICO

Just five years ago, there was no presence of motion capture technology in Mexico. Today, it has become one of the most wanted solutions for Videogame Development, Feature Film VFX & Academic Programs at Universities.

BY CARLOS LEONEL VILCHIS ZAPATA

In 2009, Universidad del Valle de Mexico (UVM) was the first international university in Mexico to purchase a motion capture set-up (T10 Cameras), which helped establish Mexico's first computer graphics, VFX and videogame academic program.

Although I didn't have any prior experience with this technology, nor was there an established workflow for teaching motion capture in Mexico, I got my hands to work to make it a reality.

As a graduate from an engineering computer science program, I also have a master's degree in 3D Animation, and worked closely for Autodesk Inc. as a certified instructor for the main 3D content creation tools.

Now, I'm a Mocap TD and a consultant for academic institutions that want to implement motion capture technologies in academic programs.

In the beginning, I knew there was only one way to do things right, and that was to emulate and follow the professional workflows that Hollywood studios have set for working with motion capture technology in the past fifteen years.

Around the same time, I also began linking together film production and videogame studios with the university so they could have access to mocap technology, free of charge, with the sole purpose of activating the industry and giving the students the chance to work closely with the professionals.

Given that there was only one mocap set-up in the whole country, it took several years for the process to stabilize, to find the balance between the content of the academic programs and the possibilities of the technology.

Today everything is different, more than two hundred computer graphics students have graduated with Vicon/Blade motion capture experience, the same students that are empowering the entertainment industry.

Image courtesy of Ana Zaha

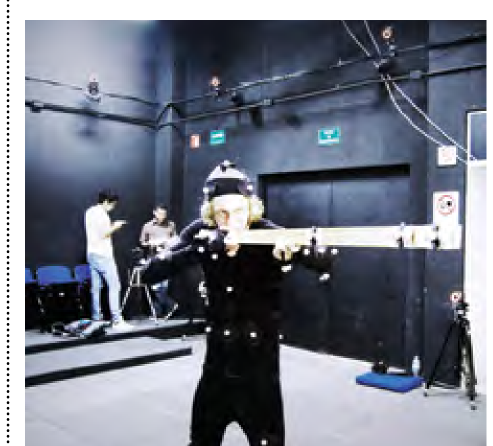


Image courtesy of Universidad del Valle de México

It was a thing of persistence, to work and work until we saw results we could demonstrate to the rest of the industry in Mexico.

It has been five years since the first mocap set-up was acquired. Nowadays, UVM has purchased another four Vicon mocap systems (Bonita), for Toluca, Puebla, San Rafael and Tlalpan campuses, respectively. Other universities have also taken the decision to implement the technology for their CG academic programs. For instance, Instituto Tecnologico de Estudios Superiores de Monterrey (T20 Cameras), Universidad Anahuac (Bonita) and Universidad del Valle de Puebla (Bonita).

As well as teaching the 3D Animation pipelines for integrating mocap data into 3ds max, Maya or Unity in those laboratories, I have also designed and installed many of the new systems across Mexico.

The biggest challenge for motion capture technology in Mexico has been to struggle against the public opinion of the Mexican entertainment industry. During the 1998 FIFA World cup, TV Azteca, a Mexican television broadcast company, experienced the misfortune of working with a motion capture solution based on Dreamteam's Typhoon, which just lead users to think that motion capture was difficult, complicated and low quality.

Today everything is different, more than two hundred computer graphics students have graduated with Vicon/Blade motion capture experience, the same students that are empowering the entertainment industry.

Thanks to this situation, many lead studios and companies are trusting in motion capture technology; they believe mocap represents a solid, affordable and efficient choice.

From a success point of view, many Mexican studios like Ollin VFX (Tron: Legacy, Pirates of the Caribbean, House of Cards), EpicsFX (Superman, The Golden Compass, Narnia) have reached out for support from us, which we've been able to supply free of charge through the linkage between Mexican universities.

Among the most interesting cases that we have tackled, capturing the locomotive motion of a horse for an epic European film, definitely stands out. As well as the case of Futuro Movil, a Mexican videogame development studio project where we had to capture a pole dancer. The challenge here was to get the job done without a motion capture suit and just the markers attached to the body.

Lemon Films, the biggest film production company in Mexico, took a step forward with motion capture solutions when in 2013 they shot the first full-CGI creature for the feature film, Km 21 Part 2. In this case we provided a 24 Bonita camera set-up for the film and six experienced students for free.

Km 31 Part 2 is the latest milestone for motion capture solutions in Mexico. In terms of the technical approach, a full facial capture was made and more than eight live minutes of full body motion.

It has not been a walk in the park, the road has been filled with challenges, what began as an experimental academic technology, has changed the way a whole industry looks up to the use of new technologies for improvement and growth.

It is wonderful how the private studios and companies have begun to purchase their own motion capture systems. Thanks to the skilled students that are trained on the industry leading hardware and software, they are becoming the game changers of the motion capture industry in Mexico.

Without a doubt, this is a clear example of how underdeveloped countries have to adopt new technologies in their favor, easing the learning task through the academic institutions and the monetary investment for private companies; it has to be a complimentary work between both agencies.

Motion capture in Mexico is on a leash, in the coming years we will see more positive results and greater projects, more and more universities are acquiring motion capture set-ups in their pursuit of motion capture technology as an academic standard.

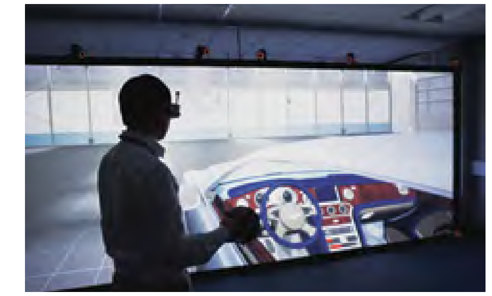
Que viva motion capture!

WORKING IN PARTNERSHIP, ENHANCING CAPABILITY

VIRTUAL ENGINEERING CENTRE

Image courtesy of the VEC

Operating across a range of sectors, we are a University of Liverpool, School of Engineering industry focused initiative, working in partnership with the Science and Technology Facilities Council's Hartree Centre, based at Sci-Tech Daresbury



Rugby throwing project at VEC.
Image courtesy of Joss Petit

BY IAIN CANT
PROJECT ENGINEER - DIGITAL DESIGN AND VISUALISATION

Working in partnership with leading manufacturers and technology partners, the Virtual Engineering Centre (VEC) pioneers new technologies and transforms emergent research from academia, to deliver 'best in class' solutions that support business growth. One such technology partner is world-leading Virtual Reality and Advanced Visualisation company, Virtalis.

Julian Ford, Business Development Manager at Virtalis commented, "In 2008, the University of Liverpool approached Virtalis with a brief to develop, install and maintain the infrastructure for an immersive Visualisation Virtual Laboratory as part of its new VEC initiative. With already well-established links, we were keen to ensure that the system was both realistic and intuitive to use. It was essential that the solution we provided to the VEC incorporated leading edge technologies, while the system architecture allowed for scalability with a high degree of 'future-proofing'.

"The specification of the 6-DOF real-time tracking system was particularly important to the VEC. Absolute accuracy and low latency were critical factors for consideration to meet the requirements of their engineering clients. We initially installed a Vicon tracking system comprising 12 Bonita Infrared cameras, the data from which is collated and disseminated by Vicon's 'Tracker' software. The cameras were strategically located around the periphery of and in front of the six meter wide screen, to the rear of which are located two, Christie Digital stereoscopic Mirage projectors, the images from which are blended to create one large, contiguous high resolution, high brightness image. Together, with two tracked users wearing NVIS ST50 head-mounted displays, the visualization system supports real-time interactive collaborative VR sessions between multiple users.

"We have upgraded the system twice within its three-and-a-half year life since installation in the summer of 2010, two years after its original conception. Recently, this included the addition of four Bonita cameras and a software upgrade to Tracker 2.0, providing an extremely robust tracking volume, essential for the VEC's virtual and augmented reality applications."

Virtalis's Visionary Render software toolkit, a relatively recent enhancement to the system, also permits real-time immersive collaboration between disparate VR systems. We expect to be carrying out more sessions of this nature, removing the necessity for all parties to travel to a single venue in order to partake in a design review, for example.

The VEC's multi-disciplinary team includes expertise across autonomous and intelligent systems, digital design and manufacturing, and engineering reliability; however, it is the unique method of the application of advanced modeling, simulation and visualization that sets us apart. We create bespoke Virtual Reality laboratories, which allow our clients to explore their designs and understand the environments in which their teams are working. The role of the VEC is to enhance an organization's capability to address their industry challenges, for example; the requirement to change the aerodynamic characteristics of a truck in order to improve its efficiency and reduce emissions or improve the design of an aeroplane wing through understanding the ergonomic considerations required for ease of access for maintenance.

The VEC's projects are challenging and as diverse as supporting the design and manufacture of the next Bentley car model within reduced development timescales, to evaluating the use of virtual environments to support and enhance the training programme of the Welsh Rugby team.
For all of our projects, the robustness and precision of the virtual world is paramount.

In supporting the rugby practice simulation, we created a virtual Millennium Stadium where a player was immersed in a virtual environment and tasked with 'throwing' a physical rugby ball towards a virtual target. The Vicon Bonita system tracked the ball at a frequency of 240 Hz. The ability to allow the player to visualize the scenario from different viewpoints while providing pin-point accurate data about the position and orientation of the ball, was an essential requirement of the client's that the system managed with ease.

Ford commented, "The VEC frequently informs me of the importance of their ability to create both realistic and intuitive virtual environments, if they are to be credible to the users and adopted into an organization's 'standard' processes and workflow. They attribute much of this to the performance and robustness of the Vicon Bonita system, which facilitates intuitive, virtually latency free interaction."

The proven quality and reliability of the existing Vicon tracking system has resulted in the VEC team replicating the installation for our new Robotics Autonomy Simulation Laboratory (RASL). RASL will provide a networked, fully tracked simulation and visualization facility that bridges the gap between advanced robotics in the laboratory and the real world.

After careful evaluation of other available tracking technologies coupled with the confidence we have gained over the last three years delivering successful projects, it was a straightforward decision for the VEC to continue working with the Vicon technology, once again, sourced from and supported by Virtalis.

The proven quality and reliability of the existing Vicon tracking system has resulted in the VEC team replicating the installation for our new Robotics Autonomy Simulation Laboratory (RASL).

A BRIEF HISTORY OF UWA

BIOMECHANICS, MOTOR CONTROL AND LEARNING GROUP

A four inch thick PhD thesis, in the area of Motor Control, Development and Learning, is the earliest record of a Vicon motion capture system being used in the School of Sport Science, Exercise & Health (SSEH) at the University of Western Australia (UWA).

Spin bowler, Muttiah Muralitharan, at UWA

BY JACQUELINE ALDERSON
ASSOCIATE PROFESSOR

The ominous looking tome was the PhD thesis of then candidate, and now recently retired Executive Dean of the College of Health Sciences at the University of Notre Dame (Australia), Professor Helen Parker.

Sometime during 1986, Emeritus Professor Parker recollects that, together with former SSEH faculty members Drs. Graeme Wood and Richard Lockwood, they "successfully applied to the university equipment fund for monies to purchase a 'part-system' – inclusive of two cameras, data input and management software modules to collect the raw files from each camera." No-one could have imagined this small purchase would form the beginnings of a 28 year relationship between what would become the world's leading motion capture company and UWA.

1986-87 Vicon Data Capture - Image courtesy of Professor Helen Parker

Following Prof. Parker's initial foray, the time and labor costs associated with data collection and processing using the part-system, meant it was used by only a small number of students over the next decade. While 3D sports biomechanics analysis was being conducted using other systems (Peak), it was not yet possible with the Vicon system. In late 1995, Dr. David Lloyd (currently Professor, Centre for Musculoskeletal Research, Griffith Health Institute, Griffith University) was appointed to SSEH and charged with leading the biomechanics group in the area of 3D motion analysis using Vicon.

In 1996, with the support of the then Head Biomechanist and now retired Winthrop Professor Bruce Elliott, and thanks to a number of initial small grants from research and charitable foundation partners (Princess Margaret Hospital, Sarich Foundation), the school undertook what was the first of many hardware and software upgrades over the following 18 year period. Not including the six camera Vicon 370 system purchased in 1999 that is still operational (though sitting in a closet), our school now proudly houses three Vicon systems; a 12 camera Vicon MX3+ system in a dedicated Sports Biomechanics Lab, an eight camera Vicon MX3+ in a Clinical Gait Analysis Lab and a 14 camera T-Series S Edition outdoor capable motion capture system. With 100 licensed dongles floating around SSEH, there is little doubt that past and present staff, and the 37 PhDs, five Masters and 42 Honours students who have completed research degrees using a Vicon system, are more than grateful for access to the state-of-the-art systems we currently house. Unfortunately, we don't have enough space to mention and thank the many people who have worked with us at UWA over the years, but here are just a few examples from a wide range of areas where we've managed to push our systems to their very limits.

Since 1996, when Professors Lloyd, Alderson, Elliott & Foster undertook the very first upper limb 3D cricket bowling analysis on the controversial spin bowler Muttiah Muralitharan, the school has been at the forefront of using customized models and Vicon systems to advance sports biomechanics analysis. Indeed, our Vicon use in cricket research is extensive and includes; improving biomechanical modeling of the elbow, shoulder and lumbar regions (Drs. Amity Campbell, Aaron Chin, Kane Middleton, Marc Portus), identifying how lumbar loads relate to injury in adolescent cricketers (Dr. Helen Bayne), describing the kinematics of spin and wrist spin bowlers, errors in the assessment of illegal bowling actions and investigating the effect of pitch length on bowling technique to name just a few.

In other sports we've used our systems to analyze the tennis serve in and out of wheelchairs (Dr. Machar Reid), assessed technique changes across the junior development pathway (Dr. David Whiteside), described the tumbling technique of gymnasts, the kicking actions of Australian Rules footballers and soccer players, flicking actions in field hockey and the mechanics of the golf drive.

And it's not just sports where we use our systems. The UWA team have also assessed lumbar loads in male ballet dancers (Dr. Luke Hopper), captured an acrobatic silks routine two storeys from the ground, described the techniques and shoulder loads of professional violinists and cellists, with current staff member Dr. Jonas Rubenson venturing into the evolutionary biologists' realm of ostrich, lizard and kangaroo locomotion (Dr. Chris Clemente). Of course, no review would be complete without mention of work in the arena of clinical gait, rehabilitation biomechanics and injury prevention. One of the first initiatives of Prof. Lloyd in the mid-1990s, was the establishment, in partnership with Princess Margaret Hospital, of Western Australia's first Clinical Gait Service. This service, in addition to the construction of the school's Clinical Gait Lab in the early 1990s, now sees clinical biomechanics as an important bow to an already large research group. Research in this domain includes; cerebral palsy (current staff members Drs. Siobhan Reid & Catherine Elliott; Drs. Noula Gibson & Sian Williams), burn rehabilitation (Dr. Tiffany Grisbrook), acquired brain injury, deep brain stimulation in Parkinson's disease (Prof. Christopher Lind), amputee gait, osteoarthritis (Dr. Tamika Heiden), meniscectomy (Dr. Daina Sturnieks), knee and hip replacement (Dr. Brendan Joss & Professor Timothy Ackland) and autologous chondrocyte implant research (Dr. Jay Ebert).

Sidestepping research at UWA

Bowling analysis outside at UWA

Finally, it goes without saying that one of the most prolific research streams in the school involves lower limb injury prevention; in particular that of knee loading and anterior cruciate ligament (ACL) injury risk. Original work in this area at SSEH was undertaken by Profs. Lloyd and Thor Besier whose research laid the foundation for numerous students to build upon; identification and modification of sidestepping technique (Dr. Alasdair Dempsey), assessing the success of training interventions (Dr. Jodie Cochrane) and the effect of vision and gaze (perception) in reducing knee loading patterns (Drs. Marcus Lee and Brendan Lay). This research area is now being progressed by current staff member Dr. Cyril J. Donnelly who is capitalizing on the extensive and ever growing database of Vicon data collected in the School, by using it in simulation research (OpenSim) to inform injury prevention training programs. With three PhDs, one Masters and two Honours students currently working in this area, sports injury prevention remains a leading research focus of the school.

However, like all successful partnerships involving leading edge technologies, there have of course been a few hiccups along the way. When a software update unexpectedly interferes with our code, or when an upgrade or new piece of equipment hasn't quite operated as we thought it might. Conversely, when the Vicon support crew, field yet another support question or complaint from one of our students (the same question they answered five years earlier), or when we jump up and down about an equipment failure, or a less than adequate result when we've used it for something it was not designed for (attempting to use our first MX system outside at night, around the water polo pool, comes to mind here). Yet, when we've needed support at UWA, and when Vicon have needed input from end-users, the strength of that 28 year relationship has shone through. Indeed, we like to think the three UWA trained post PhD support engineers currently employed by Vicon are testament to that relationship.

So, on your 30th birthday, all past and present UWA staff and students would like to thank the Vicon team, from Support Engineers to Product Development, for their unwavering support and commitment to the School of Sport Science Exercise & Heath over the past 28 years. We would also like to take this opportunity to wish you a very happy birthday. We look forward to watching what comes next from the Oxford-based research and development group, as well as continuing the strong relationship between Vicon and UWA, pushing the boundaries of research with a fantastic bunch of people, for the next 30 years.

Happy birthday!

FIVE MINUTES WITH

TONY LOMONACO, UBISOFT TORONTO

BY VICON EDITORIAL TEAM

Why did you choose a Vicon system back in 2012? What stood out or impressed you about the tech?
Vicon has a name that truly shines in the performance capture industry. At Ubisoft Toronto, our games demand the highest quality performance capture and we knew a Vicon system would best capture the subtleties and emotion of the performances for our games.

The Vicon system speaks for itself with the quality of the results it delivers. I've been using Vicon products for years and have come to know and expect a high level of quality. We shoot projects that are created at Ubisoft studios around the world, why take a chance? We went with a system with a proven track record, one that we can trust. The fact that our Montreal performance capture studio also uses a Vicon system means we can share tools, processes and experiences, and therefore collaborate with each other more effectively.

Over the past 15 years or so, what impact do you think the advances in technology have had on your ability to provide content for your clients?
Games today demand an extremely high level of realism. They rival blockbuster movies, in terms of the level of quality and the sophistication of the performance capture needed for the cinematics and animation. We are taking a more cinematic approach to our performance capture process, and this is something that's evolved in just the last few years. Today, we borrow heavily from film industry processes to help create more immersive and realistic narrative experiences in our games. We achieve a level of quality today that we could only dream of just a few short years ago.

What developments do you hope to see in the next few years?
We are working hard at Ubisoft Toronto to invest heavily in facial performance capture techniques and application, and we are making great progress, but we still have work to do. This is an area I am personally passionate about developing at our studio. I'd also love to see greater innovation for finger capture that frees our talent's performance while producing more realistic movement capture for our games with greater automation, requiring less post work by our teams.
I also envision the software evolving over the next few years to enable greater flexibility and customization for our growing performance capture needs.
A great example would be that we now require different camera configurations that are highly specific to the project we are shooting, and we envision that software will be able to help us adapt more quickly to the specific requirements of any given project by enabling presets that instantly aim and focus the cameras at the angles required for our shoots.

What do you think the industry will look like in the next 10 years?
Performance capture technologies will continually develop to fulfil a growing demand for more hyper-realistic motion, not only for body capture, but also for facial and finger capture. This will allow us to blur the lines between reality and fiction giving our audience a more immersive experience across all Ubisoft games.

Ubisoft Toronto main stage

Capture session at Ubisoft Toronto

3D sketch example

Active-motion creation in VR

SKETCH IT, GRAB IT AND WALK THROUGH IT

TECHNION ISRAEL INSTITUTE OF TECHNOLOGY INDUSTRIAL DESIGN & BRMLab MECHANICAL ENGINEERING

In design, motion capture is mostly used for the exploration and evaluation of objects in the late phase of the design process. However, it may be leveraged in the early conceptual design stage as well.

BY MS. OLGA SHAIN
GRADUATE STUDENT RESEARCHER

The design process, in general, begins with a conceptual design stage in which new ideas are born. During this stage free sketches are made and are characterized by their speed of creation and ambiguousness, as well as imprecise representation.

Even today, paper and pencil are considered to be the preferred media for free sketching. Although there are many advantages to sketching with paper and pencil, there are several inherent disadvantages, such as the two-dimensional attribute of the paper and its limited size. These disadvantages could be addressed by a system that supports easy and intuitive free form creation using a 3D space with a 1:1 ratio between the sketch and human body proportions, and an option for scale. Human centered design disciplines, such as architecture and industrial design, may gain the most of such a system. The system described below has been developed specifically to aid conceptual design, considering free form sketching needs as guidelines for the system. Our new design system allows the user to create 3D sketches with free hand motions in full body scale. The system is developed using BRMLab facilities.

'3D doodles' are created by the swing of a hand, following its exact location in space (see '3D sketches examples' figure). The hand acts as a tip of a pencil and the body as a vessel enabling the exploration of the available space. The hand and the head positions are tracked by the Vicon cameras while virtual reality glasses are used to visualize the 3D sketch. Through the VR glasses, the user is immersed into the scene of the creation and may 'walk through' the sketch. Dedicated software constructs a graphical representation of the '3D Doodles' as part of a 3D Virtual Reality scene. This is based on the positions of markers attached to the hand and the head (see marker position in 'active-motion creation in VR' figure).

The software implements the most common editing functions, such as delete, rotate, move and scale, which may be activated during the creation process.
To select an existing object for editing one simply has to get closer and, naturally, grab it. In order to make the system easy to assemble, the amount of markers for the motion capture is reduced to the essential minimum to define two subjects: the VR glasses and the active hand. The markers for each subject are specifically configured to allow for a stable recognition by the motion capture system. Being part of the design process, the raw data of the system can be saved and imported to other existing CAD software for further detailed design stages.

The system was developed as part of a research thesis towards a Masters degree in Industrial Design studies (Architecture and Town Planning faculty). The research also includes user studies that investigate user interactions with the current system. Many interesting insights are yet to come.

Thesis advisors: Prof. Noemi Bitterman (Industrial Design), Prof. Alon Wolf (Mechanical Engineering). Contact Details: **olga.shain@gmail.com**

THE MAGIC OF MOTION CAPTURE IN K-12 EDUCATION

STRING THEORY SCHOOLS

String Theory Schools, headquartered in Philadelphia, PA, offers students an innovative STEM + Arts curriculum at our new flagship high school.

Image courtesy of String Theory School

BY JASON COROSANITE
CHIEF OPERATING OFFICER

String Theory recently purchased the former GlaxoSmithKline North American headquarters in Center City Philadelphia for its new high school.

Students have an opportunity to choose a major from one of the following areas: Classical Ballet, Vocal Music, Instrumental Music, Theatre, Television & Broadcast Arts, Life Science/Biotechnology, Engineering/ Robotics, or 3D Character Design/Animation. The idea was to take the best of what Philadelphia has to offer in the arts, and combine it with its rich science heritage. The school currently enrolls 250 9th grade students but will ultimately house a total of 1400 once those students move up to 12th grade.

The integration of science, technology, engineering, arts, and math (S.T.E.A.M.) is what defines String Theory Schools. Students are prepared to become the thoughtful, creative, and innovative citizens the world needs. Their eyes light up in exhilaration. Squeals fill the air as if a teen rockstar has just taken center stage. But there is no idol to be seen, no guitar riff ringing out. What's happening at our charter school is far more intriguing: students enter the motion capture studio for the first time. We had the choice of several systems but what made us choose the Vicon Bonita 10 camera was the ease of use and ability to use the system for both entertainment and engineering projects. We wanted the entire school to have use of the studio so it had to be easy to use.

The motion capture space is configured with 12 Bonita 10 cameras mounted on a free-standing truss system. The capture space is 20' x 20' with a camera height of 10 feet. This is an ideal capture volume for the school offering a large enough space for dance with multiple individuals (the studio has a marley dance floor), and small enough to use smaller 6.4mm markers for finer placement. After going through two days of training with Vicon support engineers, 9th grade students were able to accurately apply markers to actors, calibrate the system, and map the solved skeleton to a rigged character in MotionBuilder. Students in the 3D Character Design track at the school are currently working with Ballet majors on an iPad app. The first step of which is to capture positions and movements that will be mapped to characters the students themselves create. Later this spring, they will be working with Theatre majors on a production of "Beauty and the Beast." Students are designing a 3D village for the show in Maya that will serve as a digital backdrop for the production. The school's theater is adjacent to the mocap studio and students plan to use the pre-visualization feature of Blade to render characters that appear as a live digital backdrop during the actual performance. The theatre has a 21 ft rear-projection screen that can receive an HDMI output from the capture station next door.

String Theory High School utilizes motion capture throughout its curriculum. From 3D character design to engineering and robotics, students have an opportunity to use industry leading technology.

For engineering and robotics track students, they have the ability to use Vicon Tracker. One of the more creative things students are doing with this is to track iPad controlled race cars in an Anki DRIVE™ system. Anki DRIVE™ uses Artificial Intelligence (AI) to deliver the first video game in the real world. Each car has been engineered to think, it knows where it is, makes decisions and drives itself. Students placed a set of three markers (the minimum needed) on each of the cars and calibrate the system to ignore the printed racetrack used with Anki Drive. Reflective surfaces can play havoc with IR cameras but the Blade software has a built-in auto-threshold feature to zero out random data or reflections. Students are able to accurately observe the cars as they speed around the track. Anki recently released an SDK for the system.

Future uses of the setup are to use NI Labview to interface with the cars with the Bonita system providing accurate feedback of the cars velocity and position. It's amazing to think that this is all being done by 9th grade high school students. I think that speaks to how easy the system is to use! Real time pre-visualization with rendered scenes means that what students are doing has immediate value for learning the system as well as for live productions and game development. Philadelphia has a very active film industry and typically has one to two major motion pictures shot per year in the city. String Theory Schools has offered up their motion capture studio for free to companies doing VFX work on these projects as well as independent game producers who would normally not be able to afford their own system.

LITERATURE REVIEW

ONE SMALL STEP GAIT LABORATORY

I tried to be clever while writing this literature review and develop a theme that would connect the papers I selected. What I came up with is a selection of quite independent papers, which I either found amusing or important or both.

Gluteus maximus and medialis, tibialis anterior, rectus femoris, soleus and many muscles of the upper limb are all likely candidates for subdivision. But why should a muscle be constructed in this way?

BY ADAM SHORTLAND PHD

Some people have more flesh and bone than others.
Calculated joint kinetics depend on the estimated mass and mass distribution of the limb segments (the body segment parameters, BSPs). In a recent study, **Kiernan et al (J Biomech. 2014 Jan 3;47(1):284-8)** conducted a sensitivity analysis of kinetic data to different models of mass distribution from published studies in typically-developing (TD) children. They applied these anthropometric models to children with cerebral palsy (CP), measuring the lower limb segment lengths in their subjects. According to their analysis, the estimated body segment parameters were different in controls and pathological subjects, and different between anthropometric models. However, the mean differences were small and the impact on calculated kinetic variables was negligible.

One limitation of their study, as the authors recognize, is that mass distribution data in children with CP is not readily available. The authors had to calculate segmental body masses in the CP group from anthropometric tables in TD subjects and measurements of segment length. We know that muscles and bones are reduced in mass in the lower limbs of children with CP. It is likely that if we had real mass distribution data for children with CP, our estimates of kinetic variables in this group would be significantly different to TD children, especially at higher walking speeds.

It seems to me, with the broad availability of magnetic resonance imaging, that there is an opportunity to measure mass distribution in the limbs of children with CP, and generate new anthropometric tables that could replace those of Ganley et al and Jensen.

Anatomists shout with joy, modelers repent and return to your computers. When is a muscle not a muscle? When it is two or more muscles, stupid.

Don't you love it? You think you're getting to grips with the complexities of musculoskeletal modelling (given its undeniable weaknesses: poor control algorithms, lack of validation, lack of clinical interpretability) and then up pop some folks from **LaTrobe University, Melbourne (SemCiw et al Gait Posture. 2014 Feb;39(2):822-6)** that are going to tell you a muscle that has served you well personally, and has been at the heart of many a daytime fantasy, and if you're lucky, a night-time reality, is in fact two muscles.

In this paper, the authors use fine-wire EMG during the collection of gait data from posterior and anterior segments of the gluteus minimus, that stoic hidden stabiliser of the hip. They found different activation levels in each segment and suggested that the posterior segment, which is most active during early stance, stabilizes the hip in this phase, while the cocontraction of these segments allows greater stabilization in late stance when the contact forces are acting more anteriorly.

Neuromuscular compartmentalization refers to muscles bounded by a single fascia having independent sub-volumes controlled by extramuscular branches of its nervous supply. Gluteus maximus and medialis, tibialis anterior, rectus femoris, soleus and many muscles of the upper limb are all likely candidates for subdivision. But why should a muscle be constructed in this way? In muscles with broad tendinous insertions, muscular compartments may correspond to different mechanical actions at the tendon, as in the example of gluteus minimus here. It is more difficult to justify a mechanical explanation for muscles with long tendons but perhaps, even then, differential activation of the compartments of a muscle may modify subtly the line of action of muscle forces.

Are arms better than legs?
I have a colleague (an Occupational Therapist) who, when we meet, never fails to remind me that arms are "better" than legs. Inter-professional rivalry is a terrible thing, but she has a point. The movements of the lower limb during walking lend themselves to analysis because in the typically-developing population they are consistent and characteristic of a lower level/more automatic form of motor control. The upper limb by contrast possesses a much greater neuromuscular flexibility enabling it to perform a single task with a large variation in angular trajectories of its joints. Moreover, the upper limb is required to perform a greater number of tasks of varying complexity. It seems sensible, then, that we might analyze upper limb movement in a different way to lower limb movement in walking. The paper from **Klotz et al (Gait Posture. 2013 May;38(1):148-52)** does just this. In a group of adult patients with hemiplegic cerebral palsy, they measured the range of motion at the elbow and shoulder across a range of tasks representative of activities of daily living. They found correlations between the range of motion measures and performance on an upper limb functional questionnaire, particularly in the distal extremity and particularly in supination/pronation of the forearm. The paper highlights the potential of movement analysis of the upper limb in clinical practice. Identifying the limitation in ROM at a joint might well correspond to poor performance across a range of items on a functional test. Some form of correspondence analysis may reveal the most limiting restrictions with those joints becoming a target for intervention.

And finally...

That's hard work!
Who was it who said that research work is 10% inspiration and 90% perspiration? Workers at the New South Wales Institute of Sport and University of Western Sydney have found a way to combine science and pleasure. Tight fitting garments can do a lot for the observer but I never really thought of their potential to improve movement and posture, not at least in typically-developing subjects. In this study, our friends from Oz demonstrate that tight athletic clothing actually improves objective measures of balance in female athletes during eyes closed trials indicating that proprioception in these subjects is augmented. They speculated that compression clothing may well have a role in injury prevention. Roll on the next study: compression garments in overweight middle-aged sedentary males – any takers?

A PLACE WHERE FLYING ROBOTS LIVE AND LEARN

ETH ZURICH

ETH Zurich has been a Vicon customer for over five years and in that time has achieved some amazing feats with their T-Series system. Often seen giving demonstrations to showcase the amazing ability of their quadrotors, ETH is leading the way in UAV development.

Gaby Zueblin
Raymond Oung, ETH Zurich

Markus Hehn, ETH Zurich
Cooperative Quadrocopter Ball Throwing and Catching, Google IO, San Francisco, USA. June 2012.

François Lauginie
Flight Assembled Architecture Exhibition – Gramazio & Kohler and Raffaello D'Andrea, FRAC Centre, Orleans, France.

BY VICON EDITORIAL TEAM

Here are a few pictures and video links of some recent demonstrations and exhibitions they have attended in the past year. Enjoy!

Google IO
The Flying Machine Arena team was invited to showcase its research at the Google IO developer's conference, which took place in San Francisco, California. On June 27, 2012 the FMA quadrocopters demonstrated their ability, including triple flips, cooperative ball throwing and catching, and the building of a 150 foam brick tower. The event, which also featured live concerts and various technical exhibits, was attended by over 1000 people.

FRAC Centre
Flight Assembled Architecture, a collaboration with architects Gramazio & Kohler, is an exploration in aerial construction. Conceived as a 1:100 model of a 600m high vertical village, the four day long, live exhibition, featured four quadrocopters building a six meter tall tower out of 1500 foam bricks. The exhibition took place at the FRAC Centre in Orléans, France, from December 1 to 4, 2011. The FRAC Centre is an architectural art museum on the outskirts of Paris that promotes contemporary art, both nationally and internationally. During the opening night the museum hosted 300 enthusiastic people.

Discover More
ETH Zurich's Raffaello D'Andrea presents at TED 2013:
ted.com/talks/raffaello_d_andrea_the_astounding_athletic_power_of_quadcopters.html

ETH Zurich on YouTube:
youtube.com/user/ethzurich

CAPTURING THE POWER, RICHNESS AND SUBTLETIES OF SIGN LANGUAGE

MOCAPLAB

As soon as I started MocapLab back in 2007, I wanted to explore whether it would be possible to record the complete motion of Sign Language. It just so happened that prior to getting involved in motion capture, I had spent several years dealing with deaf community issues.

Our Vicon T160 cameras did a great job. 16 million pixels, 120 fps, electronic freeze frame shutter. We couldn't have done it without them.

BY RÉMI BRUN
MOCAPLAB FOUNDER & CEO

My PhD subject at that time was "How to transform Speech into Tactile Signals for the Deaf". This research experience led me to learn in more depth about the deaf world as a whole and also to investigate on how scientists were studying speech at that time (speech analysis, recognition and speech synthesis). Coincidently when I started motion capture, back in 1993, one of my first mocap sessions consisted in motion capturing Sign Language with optical mocap at the CNRS Research Institution. It was an exciting experience, but the results were not successful enough to take it further.

Since then, it has become clear to me that Sign Language will become a very special branch in the motion capture world. Not only is this area technically difficult for so many reasons, but also, as a mocap specialist facing movement everyday over the last 20 years, I was particularly fascinated by the extremely subtle and rich movements, that convey to the full extent, this means of communication. As deaf people explain very clearly, Sign Language is as rich and as complex as our spoken language. It has its own structure, syntax and grammar. It is not a "word by word" translation of a spoken language, nor is it a type of miming. It is a real language.

The technical challenge itself is tricky. In addition to capturing fingers, one has to first make sure that the facial expressions are recorded and transferred to a mesh properly, as it is important to remember that Sign Language communication focuses as much on the face, as on the fingers. And with the facial expressions, the eye gaze direction is also a very important cue. So before tackling the finger issue, we had to make sure that our in-house tools were ready to record the face and eyes, as well as being capable of transferring the subtleties on a mesh that would not scare every deaf viewer. This was a challenge in itself!

When it comes to motion capturing hands, we focus on the 10 fingers, moving very rapidly in the air, in all configurations and positions around the body; making a lot of contact with one another, sometimes with an impact, and also making contact with the body or the face. It's a real and complex 'ballet' with five limbs, 22 DOF for each hand, with a thumb that has its own very particular way to roll. The challenge for us was to work out the right recording and synchronization solutions as well as processing tools to drive the right skeleton. And last but not least, we had to define how to rebuild the fingers' mesh to ensure an accurate final mesh surface positioning in order to enable a good quality contact between the two hands.

The results so far have been very rewarding and the feedback from deaf viewers has been extremely positive.

It is important to bear in mind that in general the deaf community, for historical reasons, is not at ease when it comes to scientific research and avatars, and usually remain very sceptical about the results. Despite the very low quality of our mesh and rendering, the feedback remains very promising. Actually it is important to mention that we kept ourselves as far away as possible from photorealism, to avoid comments and reactions on the modeling/rendering, allowing the viewer to focus primarily on the animation side. Of course we will try photorealism too, which you can see in the video links on the right.

In addition to this, we have also had some unexpected and interesting comments from deaf viewers. For example, some viewers personally knew the signer behind the mocapped movements driving the avatar, and recognized her immediately through her signing. This was also the case when the 3D model of the 'avatar' was simply made of cubes for the body and fingers, with no facial animation! As a comparison, it would be just like hearing people who recognize someone by their voice on the telephone.

Other interesting comments were based on the 'accent'. The signer we used was signing in ASL (American Sign Language), yet her native sign language was New Zealand Sign Language (which is very close to British Sign Language). In her avatar, when signing ASL, deaf viewers could sometimes guess her origins from the 'accent' in the movements recorded!

So the whole experience has been incredible. We've worked hard, we've pushed boundaries, and we've learned a great deal about the power, the richness and the subtleties of human movement.

I am sure the path will continue, as this is just the first step. We are currently finishing a research project to create a tool for Sign Language that would be like "Pro Tools" for sound engineers. It will be a tool box to analyze the Sign Language signal through all its aspects, as scientists did for speech 30 years ago.

Discover More
mocaplab.com
vimeo.com/mocaplab

Mocaplab's ASL signing avatar:
vimeo.com/89629973

A photorealistic animation project from Mocaplap:
vimeo.com/80051522

FULL CIRCLE

AUDIOMOTION

Image courtesy of Audiomotion Studios

BY MICK MORRIS
MANAGING DIRECTOR

I read an article recently which made me smile. It was an enthusiastic report about how the medical industry is now using motion capture technology from the movies to analyze patients' movements. To be fair, the journalist might not have been too well informed about the origins of this amazing 'new' technology. A little bit of research and fact checking would have revealed that part of the story began with Vicon, thirty years ago!

When we bought our first system from Vicon 17 years ago, it was the cutting edge 370. There were very few people in the entertainment industry who knew anything about motion capture at that time, whereas the medical and biomechanics world was well aware of what could be achieved with the technology. As the visual effects world began to take notice, Vicon were already developing software and hardware which could handle the needs of this fledgling area of movie making and games development.

By the time the Vicon 8 was ready to ship, Audiomotion upgraded to a 17 camera system. This was probably one of the largest in the country at that time. It was more than adequate for recording the movements of one or two people even if the software left something to be desired. It was used to full effect on Ridley Scott's Gladiator, the movie for which the Mill won an Academy Award for best Visual Effects. The Colosseum could have been populated without using the Vicon system but it would have taken an excruciatingly long time.

In the years since, we adopted the MCam, the MCam2, the MX40, the F40 and most recently the T-Series. Simply put, there has never been a competing product brought to market that would persuade us to change supplier. Today we have 160 cameras and there are very few projects we can't tackle, as can be seen in the recent Hollywood block-busting zombie flick World War Z. We created a giant capture volume at Shepperton Studios for the movie and the results were then turned into hundreds of thousands of the CG undead. Total Film described the movie, "There's never been a more impressive horde on the big screen. Sprinting, gnashing, leaping and head-butting their way through civilisation in a swarm of thousands, the Zombie apocalypse finally looks big enough to be believable."

Another recent breakthrough is the rock-solid real-time visualization which is the result of combining the T40 cameras and Blade. It makes rendering up to 10 performers in real-time, seem effortless. A future step will be to incorporate the aesthetic head-mounted camera into the pipeline. Something we are very much looking forward to.

Audiomotion's main stage

We are very proud to have played our small part in Vicon's 30 year history. Here's to the next 30 years. Congratulations to all.

THE STRATHCLYDE MAFIA

UNIVERSITY OF STRATHCLYDE

The Biomechanics group at the University of Strathclyde is 50 years old this year. To celebrate, we bid for, and have been awarded host status for the 25th ISB Congress 2015, which will be held in the Scottish Exhibition and Conference Centre here in Glasgow, Scotland the week of the July 13, 2015.

BY PROF. PHILIP ROWE

Strathclyde University's
Vicon lab in 1988

It is with great pleasure that I can announce Vicon will join us as Diamond Sponsors of ISB 2015, which we consider a great way to celebrate their 30th birthday! Further details of ISB 2015 are available on our website isbglasgow.com.

Biomechanics here at Strathclyde began in the early 1960s with the pioneering work of Professor John Paul. John, a Mechanical Engineering Lecturer at the time, was approached by the Professor of Orthopaedic Surgery in Glasgow, to help improve joint implants so they "did not keep breaking". John initially thought this would be a simple task but it became a lifelong enterprise. Prof. Paul built the original 3D motion system at Strathclyde, using three cine eight video cameras. He hand-digitized every frame to locate markers, calculated 3D marker positions with pen and paper, and used two early force plates to calculate the kinematics and kinetics of human movement for the hip and knee during a number of activities. Something this generation of movement scientists can only marvel at.

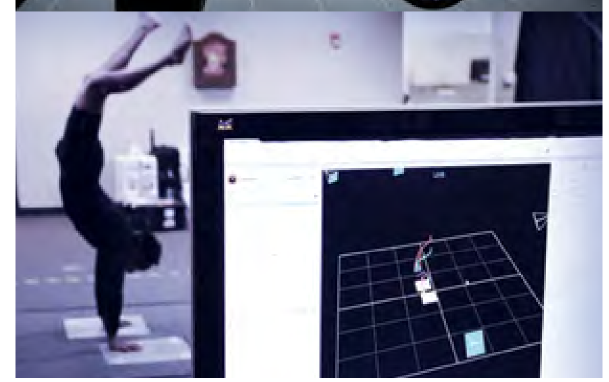
In the early 70s, the cine cameras were replaced with the newly developed "TV" cameras. Hand identification of markers and calculation of forces and moments, was slowly computerised by a succession of students. Through this work, Strathclyde considers itself to have helped give birth to Vicon. The picture of our old lab shows the biomechanics facility as it was in 1984; when I started my PhD here, with the TV camera on a stand and the calibration board to the right-hand side. By the time I left the bioengineering unit in 1988, the department had decided it really needed to convert from its own prototype equipment to the increased capabilities offered by the early Vicon systems.

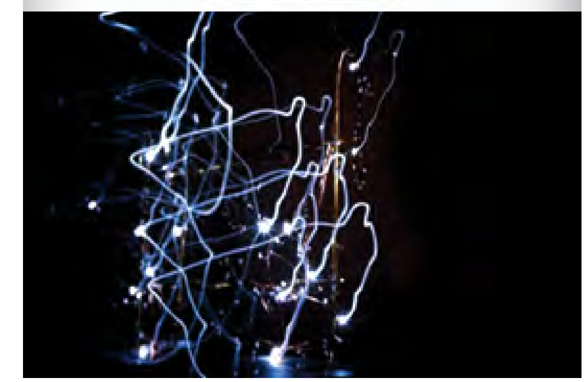
The Biomechanics group using Vicon technology has played a full and active part in the 30 year history of the company. They contributed valuable research work training over the years, which lead to the references often made in our field of the "Strathclyde" mafia, as former students of the group have become known. These developments were overseen by Professor Paul and most recently by Professor Sandy Nicol, another huge contributor to our field. It was with some trepidation therefore, that I took on leadership of the group in 2007 on Sandy's retirement. However, we continue to flourish and have recently upgraded our lab once more to the latest Vicon technology.

ISB 2015 was to have been an event to thank John Paul for his contribution to biomechanics but unfortunately he died at the end of last year. We plan to make it a celebration of his life, 50 years of Strathclyde biomechanics, 25 ISB world congresses and 30 years of Vicon's leading technology. We hope you will join us for what promises to be a great celebration all round and some serious science as well.

The Biomechanics group using Vicon technology has played a full and active part in the 30 year history of the company.

VICON STANDARD





CAN YOU CAPTURE THIS?

VICON

BY IMOGEN MOORHOUSE

CEO

I joined Vicon in January 2001 as a (fairly) fresh faced 28 year old Life Sciences Sales Engineer. What led me to apply for, and ultimately accept the position, was the challenge of international sales combined with the absolute connection that exists between Vicon technology and real world issues. A lot of technology, although engaging from a purely engineering perspective, does not have this essential link.

Very early on in my first year at Vicon, I was fortunate enough to attend the gait analysis course run by the University of Dundee. For me, this clearly set out our user needs, and over these last 13 years that fundamental need has not materially changed.

My sales career took me to far flung laboratories in Europe, Asia and beyond, and, without exception, all our users had the same common goal; to help people improve their quality of life. One of my most challenging early demos for Vicon was on arrival at a biology department in Belgium. I was presented with a gecko, with its own treadmill and fine-wire EMG system, and asked 'can you capture this?'. With a bit of head scratching, a pair of ladies nylons, a clockwork toy mouse and a vivarium, I successfully demonstrated it was, and won the deal. I think that was when I realized this wasn't going to be a job when any day was the same as the last!

In those days the heady heights of fully automatic real-time systems were not the reality as we have today. Analog cameras, off-line reconstruction, labeling and modeling with low camera counts, resolution and frame rates, made up a standard system.

At the same time, our other major market in entertainment was moving into a very aggressive period of expansion, in terms of technological advancement and wide scale adoption of motion capture for film and game content.

In 2003, Vicon supplied the world's largest motion capture system to Sony Pictures Imageworks for multiple actor capture for film. It became clear over the course of this project that the requirement for digital, real-time systems in this industry was an absolute must.

Therefore in 2004, Vicon launched the world's first four megapixel motion capture camera, the MX40, which connected to a fully digital system architecture with real-time provided by Vicon iQ software. The new platform was extremely popular, and our life science customers also saw the benefit; a higher resolution camera able to deal with a larger number of smaller markers to capture foot and hand movement or faster sports moves with ease.

The MX platform developed through several iterations, with 2.0, 1.3 and 0.3 megapixel versions alongside the Nexus software platform specifically designed for life science needs.

At this time, I was working as the General Manager, looking after the production facilities as well as sales and support. We introduced ISO9001 and ISO13485 accreditations during this period. ISO9001 principles are mostly familiar, but ISO13485 encompasses all aspects of development and quality assurance of our products, and is a Medical Device Standard. It was no mean feat to gain this and we are one of only two companies in motion capture with this standard.

But, as always, my colleagues in the R&D department were hard at work, and by 2007, the development of a new and ambitious motion capture platform was well underway. Vicon has always been able to take off-the-shelf products and repurpose them for motion capture, but some technical compromise is always required using this approach. Over the previous years we had moved into designing our own cameras and distribution boxes but still had to rely on general purpose sensors and lenses. In 2008, with the launch of the T160, Vicon had not only produced a camera with four times the resolution of previous generations, but with a sensor with a matched lens range designed entirely for motion capture.

The T-Series was an immediate success, but our markets were also demanding a lower cost offering, primarily for tracking in engineering applications. Vicon's answer was to produce the Bonita camera range, which has quickly grown to be our most successful camera. Bonita cameras have been used in such diverse engineering applications as in-vehicle driver assessment, UAV tracking, analyzing the movements of excavating equipment and robots. But as seen in previous years, a technology that had been primarily developed for one market, was quickly taken up by others, and Bonita has been very successfully used by life sciences and entertainment customers in areas such as running injury assessment, pre-visualisation and high street store layout design.

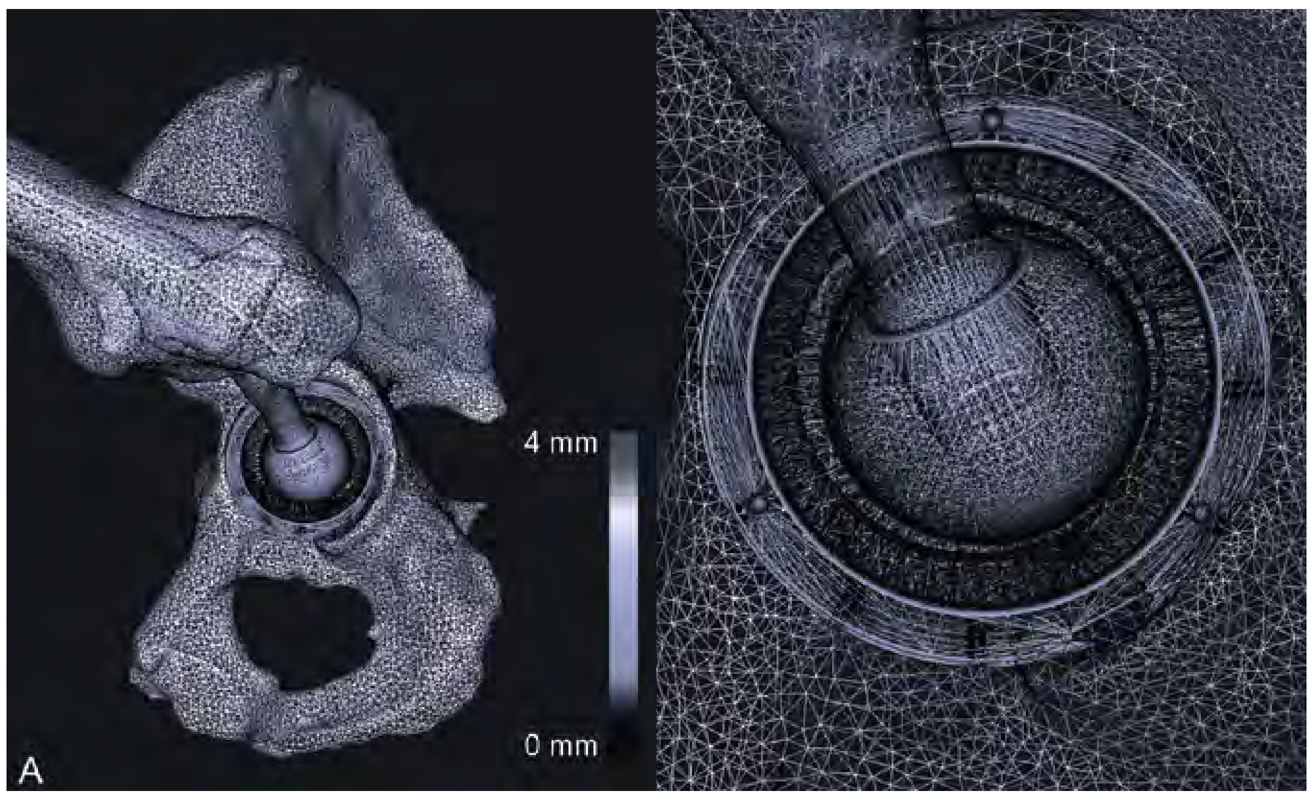
The Bonita range was then extended to include a higher resolution camera, the B10, plus several video camera options. In parallel, our development teams were working on our independent video capture and logging system called Pico. Back in 2007, Vicon assisted a large US film effects studio with a one-off prototype head-mounted system for facial capture and tracking, used in several major feature films. The Pico project took some of the basic principles of this prototype, such as miniature video cameras, automatic blob tracking and wireless control, and turned them into a commercially viable proposition. The first product to be launched based on Pico, is Vicon Cara, our head-mounted capture and tracking system, launched in 2013. We are in the process of exploring new markets for the Pico system, so watch this space.

But we are not resting on our laurels by any means. Vicon is working on a number of exciting new projects, which will launch soon, and we know will provide genuine added-value to customers old and new, while providing true innovation. This, combined with our world class support teams and resellers, means the future is looking healthy for Vicon motion capture in whatever form it takes.

SEX AFTER HIP IMPLANTS

A GUIDE BASED ON MOTION CAPTURE

ARTANIM



Motion capture in the biomechanics field has a long history. Since the pioneer work of M.A. Lafortune in 1984, this technology has continuously provided valuable answers in understanding the mobility of the human joints.

BY CAECILIA CHARBONNIER
CO-FOUNDER AND RESEARCH DIRECTOR

I remember the day when Dr. Panayiotis Christofilopoulos, Orthopaedic Surgeon at the University Hospitals of Geneva, came to my office. He told me, "I have a new project. I would like you to analyze what are the best sexual positions that could be performed after total hip replacement". I replied, laughing, if he was kidding me. He said, "No, I am not this is a very serious scientific question. Lots of my patients wonder about the risks related to sexual activity after surgery and I have no answers to provide them!"

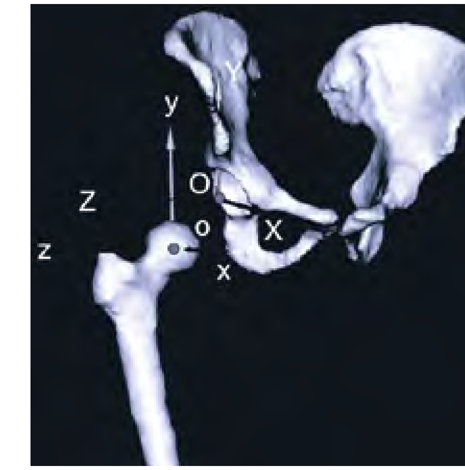
Several months passed. My team and I were very busy working on the research project MyHip whose aim was to improve the surgical planning for total hip arthroplasty (THA). In this project, we were in charge of the simulation of prosthetic hip joint 3D models based on motion capture data of daily activities. It is at this particular moment I thought, why not capture sexual positions? After all, these movements are part of everyday life and sex is the oldest recreational activity of all! This is how the study began. We asked Medacta International SA, who were also involved in the MyHip project as industrial partner, for their authorization to use their prosthetic models for a very uncommon study. They agreed and we started looking for volunteers willing to participate in the study. The research questions were twofold: first, to quantify the hip range of motion necessary to perform sexual positions, which was unknown at that time; second, to objectively evaluate during their practice the relative risk of impingement – when there is a collision or contact between the prosthetic implant components or bone-to-bone contact. When this happens, there is a greater risk that patients can dislocate their hip. Although there have been some studies that have looked into this matter, for instance, by means of questionnaires relating to sexual difficulties before and after THA, this aspect remains largely unexplored and rarely discussed between patients and surgeons.

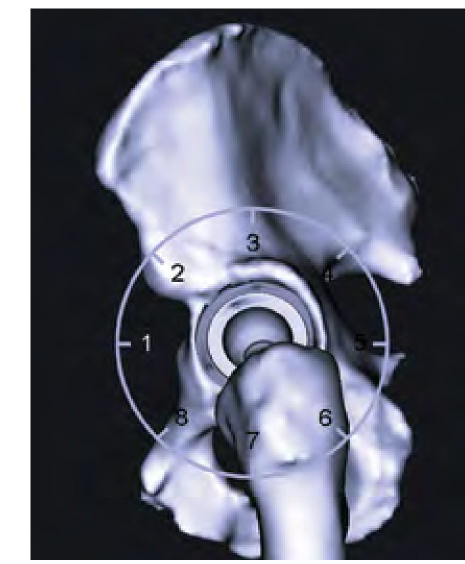
Several weeks later, we were ready to acquire the necessary data for the study. Two brave young and healthy volunteers, one female and one male, accepted to undergo Magnetic Resonance Imaging (MRI) and motion capture. The MRI scans were used to reconstruct 3D models of their hips and to verify that no joint abnormalities could affect the results of the study. We planned the motion capture session at night when everybody left the lab. After being sure to have locked the studio's door, my colleague Sylvain Chagué and I equipped our two volunteers with reflective markers, and we captured twelve different common sexual positions with our 24 T40S cameras. The session lasted about two hours. The day after, we tackled the post-processing of the data. As you can imagine, we were faced with many marker occlusions but it wasn't an issue thanks to Vicon's Blade.

The data was imported in custom software and the hip joint kinematics were computed from the recorded markers trajectories. This was achieved using a previously developed optimized fitting algorithm which accounts for skin motion artifacts and patient-specific anatomical constraints. This algorithm has an error of 0.5 mm in translation and < 3° in rotation, which is quite accurate. The resulting computed motions were applied to the volunteer's hip joint 3D models, reconstructed from their MRI data, and hip ranges of motion were determined at each point of the movement. The next step was to evaluate joint instability and to determine whether or not impingement occurred during sexual activity after THA. The recorded kinematic data was hence used for the simulation of prosthetic hip models. We tested and simulated nine implant configurations to account for the different ways in which surgeons have implanted the prosthesis. Whenever impingement occurred, we noted down the location and range of motion responsible for that impingement.

Results showed that sex posed a greater risk for woman than for men, because more mobility was required for the various sexual positions that involved extreme hip flexion and abduction. Out of the 12 sexual positions, we found four positions for women that should be avoided and only one position for men. This means patients can still have good sex after their surgery.

Motion capture in the biomechanics field has a long history. Since the pioneer work of M.A. Lafortune in 1984, this technology has continuously provided valuable answers in understanding the mobility of the human joints. Over time, motion capture systems have become more and more precise allowing researchers to study increasingly complex movements, from a simple walk to high performance sport, and now sex. Thanks to this technology, we were able to provide surgeons with specific instructions or guidelines to patients' enquiries. I believe that such a study can help a lot of patients having total hip replacement today.





Images courtesy of Artanim

Discover More
Caecilia Charbonnier talks to Reuters about her hip implant research: reuters.com/video/2013/11/18/reuters-tv-sex-after-hip-transplants-scientists-rev?videoId=274562919&videoChannel=118065

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Image courtesy of Industrial Light & Magic

EMERGING, IMMERSING, CONVERGING;

WHERE WILL THE STORY LEAD?

VICON

BY PHIL ELDERFIELD

PRODUCT MANAGER - ENTERTAINMENT

Mention motion capture to the person next to you on the train today and it's a fair bet they'll know what you're talking about. This wouldn't have been the case just a few short years ago. Over the past 30 years of Vicon's history, mocap has been demonstrated to monarchs and presidents; seen and used by politicians, engineers, artists, doctors, celebrities (A to C list) and scientists. There are few who don't recognize the dark suit and white dots as a piece of Hollywood trickery.

This broad domestic recognition is indicative of the ubiquity of motion capture within the film and games industries where it has reached almost the point of being taken for granted as a production tool.

It's not just about fast turnaround animation any more, though of course productivity gains are still important. Now, everyone talks about the 'performance' – and with good reason. The terms performance capture and motion capture have become interchangeable and doubtless the former will replace the latter completely in the coming years.

But cameras have been capturing performance motion since the dawn of the moving image, though with a traditional camera you get what you shoot and only what you shoot. Different camera angles require different takes so careful planning is crucial for both productivity and creative reasons. You need to know what you want before you start.

For a performance, mocap effectively allows shooting infinite angles in one take. This can defer some of the decision making process to later in the production pipeline and allow immense creative flexibility.

While we have a long way to go, for me, the logical conclusion of all this, is the complete replacement of traditional 2D cinematography with 3D capture for every production type. Mocap becomes digital cinematography, a kind of 'captography'. Just as silver nitrate was replaced by pixel values as a means to capture light, so 2D electronic images are replaced with a different kind of digital representation where the output is the entire 3D performance stored as motion data rather than a set of image files.

You might reasonably question whether all this flexibility is a good thing. Could it muddy the creative vision with too many post production possibilities and result in sloppy, up front decision making? I've seen this kind of thing first-hand through days spent in cutting rooms wading through thousands of feet of footage shot by directors who covered everything from every possible angle. In those days, one measure of a director's credentials was the number of feet they shot per day, fewer being indicative of clear vision, good planning and a promise of clarity of result.

However, not only does mocap provide a superior tool for previsualisaiton and shot planning to help the decision making process early on, my experience has been that a good director will always have a clear vision and execute cleanly to it. Increased flexibility will provide for experimentation and finesse under the control of that vision at all stages of production, before, during, and after the shoot, promising almost infinite creative possibilities, but exploited with structure and within budget and schedule constraints.

It will become more and more important that the director, performers and crew are able to visualize and explore the digital environment in real-time as they shoot, and this will require reduction in system footprint and increase system transparency. Mocap must perform unobtrusively in the most physically and politically dynamic, demanding and pressurised of environments – the film set.

You may well think these ideas a little fanciful but I believe we are already taking strides in this direction and the noises being made in a few important sectors certainly suggest a desire. That said, there is a great deal to be done before it becomes close to reality and the barriers are as likely to come from acceptance by some of the more intransigent areas of the industry as from the technology.

Of course, motion capture alone will not make this possible. Significant advances are required in rendering, lighting, modeling, simulation, hardware and software, across the face of digital production to achieve photo and motion realism comparable with current digital photography. For games, there has been a swing in recent years toward the type of title which lends itself to the huge variety of currently available digital and mobile delivery mechanisms, which don't always demand the same level of detail or narrative thread found in their console counterparts. Narrative, however, will always be part of the picture and, I believe, story and character driven games will remain a vibrant part of the mix. Increased believability of performance, both in game and in cinematic form, will allow the player to connect with characters in much more complete ways. Ongoing improvements in immersive technologies and the drive toward wearable tech, can, and will exploit and compliment motion capture techniques. These technologies combined, will grow in importance for both content creation and player immersion.

So, what are these advances which will make high quality, accessible mocap possible anywhere? Well, without going into detail, many will come through software and processing, where much more will be made of limited data sets. This will help make motion capture truly accessible to a wider range of user, and usable in the most difficult of environments. In hardware, robustness and reduction in footprint and physical impact will make the technology recede, and allow the creative process to flourish. Complimentary data acquisition sources may be used to increase the pool of information on which the clever processing can work, each source overcoming limitations of its counterparts.

The still settling discipline of facial capture is key to the delivery of computer-generated imagery which is as representative of an actor's performance as its camera-generated counterpart. Work currently underway in this area, driven by obvious demand, will lead to methods both unintrusive and accurate.

Another area where we will see expansion of the use of capture technologies is in broadcast, where real-time interactions in virtual worlds will become more commonplace for viewers and participants, and as a production technique. The immediacy of the current level of real-time feedback offers intriguing possibilities for the world of TV production and I believe we will see more and more evidence of this over the coming years.

Despite its 30 year history, its ubiquity and the transition of motion capture from the magical to the commonplace, I can't help feeling that actually we're on the verge of a new and significant period of virtual entertainment, where motion capture and completely new technologies are set to radically change for the better, the way we produce and experience our art and entertainment.

EON REALITY HELPS DISCOVERY WORLD GUESTS SEE MILWAUKEE DIFFERENTLY THROUGH VIRTUAL REALITY

EON REALITY

Discovery World connects innovation, science, technology, and the environment with exploration and learning through interactive exhibits and experiential learning programs.

A family exploring the solar system in the HIVE

BY VICON EDITORIAL TEAM

They are dedicated to helping people positively impact their communities by developing a better understanding of technology and the environment while fostering both innovation and creativity. The 120,000-square foot facility includes interactive science, technology and freshwater exhibits, learning labs, theaters, television and audio studios, and fresh and saltwater aquariums.

The Challenge
Discovery World was looking for a solution that would bring the city of Milwaukee to life for their guests, utilize their existing resources and partnerships, and help the institution fulfill its mission statement.

Create Virtual Milwaukee: Discovery World wanted its guests to get to know the city of Milwaukee in a completely new way. They wanted a three-dimensional model of downtown Milwaukee that citizens could virtually explore and interact with. By doing so, Discovery World sought to enable visitors to visualize what opportunities Milwaukee holds and inspire its guests.

"We want visitors to have the tools to imagine and visualize the future of their community. By taking something familiar and showing visitors a new way to look at it, we spur creative ideas of what tomorrow may look like and how we can improve our community in the future," said Discovery World President Joel Brennan.

Utilize Existing Creative Resources: Empowering their current resources was another key need for Discovery World. With their strong ties to local universities, Discovery World was looking for a solution that enabled easy collaboration and would easily import popular file formats from industry standard CAD and 3D modeling products.

The HIVE installation at Discovery World EON Reality's Solution

All images Courtesy of Discovery World

Discover More
See a video of the HIVE in action at: youtube.com/watch?v=D8NcH49Waa4

Inspire Its Visitors: A pretty display would do very little for the Discovery World in the grand scheme of things. The proposed solution would have to inspire and educate their guests in accordance with their mission statement to develop a better understanding of technology and the environment while fostering both innovation and creativity. A solution that could grow with Discovery World's needs and create a fully immersive experience was a necessity.

EON Reality installed an EON Icube with a Vicon tracking system at Discovery World's facility, called the HIVE (Hybrid Interactive Virtual Education). The EON Icube's four-wall projection system accurately simulates a 3D environment by being able to re-render the projected images from the user's perspective in real-time.

EON Reality installed seven Vicon Bonita cameras for cost effective yet reliable, high-performance motion capture and Vicon Tracker software to track people's heads. Tracker's precise, low latency tracking makes it ideal for maximizing the user's sense of immersion in the virtual reality environment.

"It's the difference between watching from home versus going to a live event," said Paul Hayden, Director of Exhibit Integration "When you have the right views and head tracking it's an overall better experience. Watching people look over a virtual railing and getting a feel for the height in the simulation is incredible."

Accurate Virtual Milwaukee: EON Reality worked collaboratively with Discovery World to create Virtual Milwaukee, a 3D digital recreation of downtown Milwaukee. Virtual Milwaukee was created by compiling real terrain, elevation, and infrastructure data to build an accurate computer-generated version of downtown that can quickly be updated with data provided by city planners and architects. There are tentative plans to expand the model to include bus routes and the city's old steam tunnels.

Collaborative Immersive Platform: The EON Icube's ability to easily import different modeling and CAD formats has made the HIVE a centerpiece of local collaboration. With the ability to work with local educational institutions and utilize in-house resources, Discovery World's HIVE is a true teaching environment and research platform rather than just a display device via their local partnerships.

Discovery World is able to quickly move a project from an idea, to a 3D model, all the way to a real-time rendered virtual 3D object.

Sparking Learning: With 30 simulated environments, Discovery World's Icube gives its guests an opportunity to venture beyond the walls of the facility and walk among the planets, take apart an engine, or ride a roller coaster.

"The Solar System simulation is one that really showcases the immersive aspects of the HIVE," said Hayden. "Scale becomes so real in the immersive environment. Especially with the head tracking system, it makes what you're teaching much more tangible for children than flipping through a boring textbook."

Key Benefits
Virtual Milwaukee can be used for urban planning and is extensible to mobile devices for tourism applications. City life can be simulated to monitor how changes to the cityscape affect the people of Milwaukee. For instance, architects can add new buildings to see how they impact the city's skyline.

Also by utilizing Discovery World's connections to local universities, such as Marquette University, they have embarked on several of their own simulations, like a virtual operating room. An enterprising medical student created an arterial simulation placing the viewer in the middle of the carotid artery with mathematically modeled blood flow and arterial wall movement.

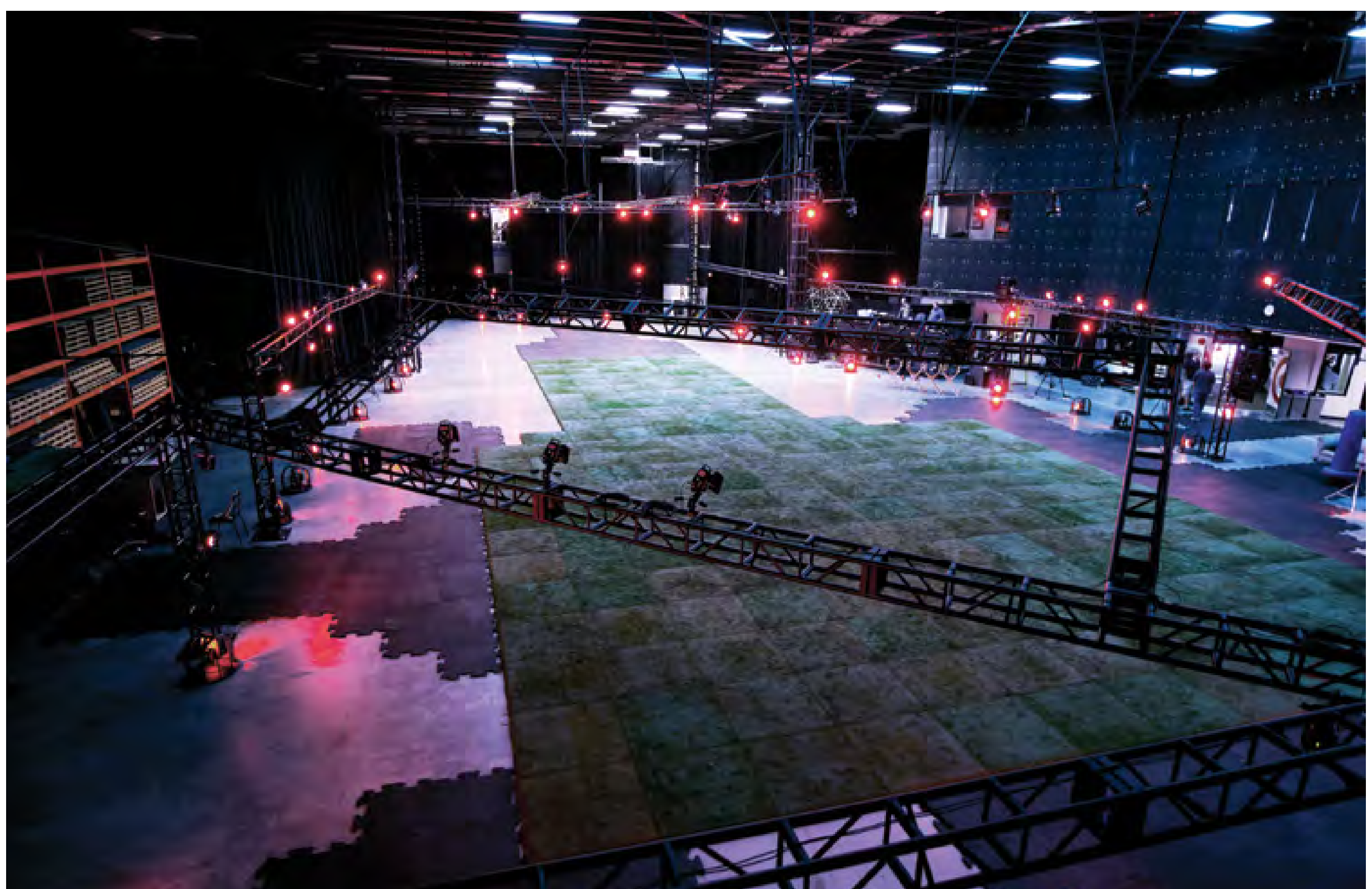
The HIVE has become one of Discovery World's more popular exhibits. On weekends, you cannot get a HIVE viewing unless you book a time in advance, and on average six to seven people move through the HIVE every 10 minutes six days a week. Since 2008, 1.7 million people have visited Discovery World and approximately 250,000 people have directly engaged with the EON Icube powered by Vicon's motion tracking system.

Key Benefit Highlights
- An accurate 3D simulation of downtown Milwaukee for city planning use and learning.
- A unique experience for guests to get excited about learning and technology.
- Showcases how virtual technology is used in industry and education.
- Opportunity to explore environments and scenarios not typically available to others in the same type of industry.
- An exhibit that differentiates Discovery World from similar facilities.
- Can be updated, upgraded, or repurposed in the future.

THE CAPTURE LAB CREATES THE WORLD'S LARGEST MOTION CAPTURE VOLUME WITH VICON BLADE

THE CAPTURE LAB

Based in Vancouver, Canada, The Capture Lab is the world's largest motion capture facility. Since 1996 it has contributed motion capture, digital doubles, facial animation, and virtual camera services to more than 225 high-end animation, video game, and visual effects productions around the world.



"With the sheer volume of data that we capture and process, we rely on the cameras, software and hardware to perform together flawlessly every time. Downtime isn't an option, and Vicon's system keeps us up and running."

BY VICON EDITORIAL TEAM

Recent projects include Electronic Arts' award-winning first-person shooter game Battlefield 4, 20th Century Fox's Percy Jackson: Sea of Monsters, and EA SPORTS' FIFA 15.

Thanks to Vicon's Blade 2.6 motion capture software, The Capture Lab has more than doubled the size of its motion capture volume, creating the largest entertainment capture stage in the world. The increased functionality of the new software allows The Capture Lab to deploy 132 Vicon cameras, covering a massive 50'x130'x15' volume, through one aggregated system.

"The new link aggregation feature was a huge win for us this year," explains Brad Oleksy, Director of Studio Operations at The Capture Lab. "The ability to run everything on one system has greatly increased the accuracy of timecode sync, camera calibration, and the resulting animation. We no longer need to merge three separate systems together. Blade's volume visualization tool was also essential to the creation of the massive shoot volume. It enables us to ensure accurate camera coverage information without the need for iterative testing; a huge time saver for our team."

"The familiar, user-friendly interface has facilitated the adoption of the new Blade software at The Capture Lab," says Jeremy McCarron, Director of Strategy. "The Axiom engine has improved our real-time display and increased our pre-visualization capabilities, allowing directors to see the animation, characters, props and set pieces 'in camera' and focus on achieving their creative vision instead of wondering if they got the shot."

Vicon's Blade software enables effective production pipelines and workflow efficiencies, with solid real-time performance, and integrates seamlessly with Vicon's T-Series and Bonita camera ranges. For fast-turnaround material, Blade's QuickPost feature allows users to automate the post processing workflow, including reconstruction, labeling and occlusion fixing and solving - reducing the need for time-intensive manual clean up. Its HSL API enables The Capture Lab to customize the software to its specific needs.

According to McCarron, The Capture Lab opted for Vicon based on its accuracy and stability: "Vicon's motion capture system is robust enough to stand up to the rigors of production," he explains. "With the sheer volume of data that we capture and process, we rely on the cameras, software and hardware to perform together flawlessly every time. Downtime isn't an option, and Vicon's system keeps us up and running."

"We need to focus on production and getting amazing animation into our customers' hands, so the on-going support Vicon offers is invaluable," concludes McCarron. "Whether loaning us equipment during routine maintenance, consulting on pipeline efficiencies, or collaborating on new technologies, Vicon has been an important part of The Capture Lab's success."

ESTIMATING THE HIP JOINT CENTER WITH MOCAP AND ULTRASOUND IMAGING

UNIVERSITY OF OTTAWA

BY MS. SWATI UPADHYAYA, AND DR. WONSOOK LEE

The precise location of the center of rotation is needed for various applications ranging from gait analysis, to being used as a reference point in navigation based surgeries.

Humans have an urge to make things better using existing technology, that's why, when presented with the idea of locating the center of rotation of the hip joint, we decided to use an approach based on motion capture.

This well established method for non-invasive determination of the hip joint center (HJC) is called functional approach, in which external markers are placed on the thigh and pelvis. While the hip joint is modeled to be a ball and socket, the thigh is made to move with respect to the pelvis, such that the marker trajectories are recorded and then analyzed through various algorithms to find the center of rotation. The 3D marker positions were recorded using a Vicon system because of its sub-millimeter accuracy, which is an essential requirement in medical applications. The recorded movements are assumed to be representative of the underlying bone, although due to the non-rigidity of the overlying soft tissues, this assumption does not quite hold true, and results in the inaccuracy in determination of the HJC.

Many measures have been taken to resolve this problem in the past, however a need to link the overlying marker positions with the underlying bone movement still exists. To tackle this, we came up with the possibility of combining the evergreen Vicon system, which records the external marker positions on the thigh and pelvis, with ultrasound imaging, which is a portable and non-invasive way of locating the underlying bone.

The experimental setup consisted of an ultrasound imaging machine (Picus, Esaote Europe), a linear probe (L10-5, 5 MHz operating frequency, width four cm) and the motion capture system, which consisted of six Vicon MX40 cameras operating at 120 Hz. Nine retro-reflective markers were used, three on each thigh and pelvis, and three on the probe with an extension to track the position of the probe movement. Four researchers took part in the initial exploratory research needed to form the design of the research. The ultrasound images were obtained at a frame rate of 30 Hz for six seconds, which gave 180 frames of recording for each capture.

Our aim was to record the movement of the thigh, pelvis and the ultrasound probe through the Vicon system, while the leg of the participant was flexed. At the same time we needed the ultrasound placed on the thigh, such that it recorded the change in the depth of bone during the movement.

The markers on the thigh, pelvis and probe form the local frame of reference, which is used to calculate the position vectors and rotation matrices for the respective segment. These are used in traditional coordinate transformation algorithms to calculate the HJC, with an accuracy of up to 15mm in human participants.

We recalculated the position of thigh markers using the bone depth information available from ultrasound images obtained on the thigh. The 3D position of the bone was estimated using the probe's local frame of reference and the ultrasound image data. Both systems, ultrasound (30Hz) and Vicon (120 Hz) were synchronized by time stamping and graph analysis. The centers were recalculated using the new marker positions and compared for four participants. The algorithms give two centers for the hip joint, for the two segments involved. The distance between the two centers needs to be minimized and serves as a measure of accuracy of the algorithm.

The mean residual has been improved by 46% with the combination of ultrasound imaging with the high resolution Vicon system, with an accuracy of ± 0.04. This experiment is suggestive of opening new doors to the possibility of combining the two non-invasive imaging technologies to better estimate the hip joint center for various clinical and educational applications.

CLIENT SERVER APPLICATION FOR REAL-TIME AVATAR ANIMATION

CENTER FOR INFORMATION TECHNOLOGY RENATO ARCHER

BY TANIA LIMA & MARIO ROCHA

The purpose of this work is to increase the research capacity of our motion capture projects using the Vicon system. This makes the system more accessible and more likely to be used by a greater number of people, regardless of their physical presence in the laboratory.

In this article we show the results of some software techniques that can be applied to increase the frame rate of a real-time avatar animation when streamed over the network, with data captured by a Vicon system.
This is a continuation of our last work, in which we presented the steps to develop an avatar-interpreter of the Brazilian sign language for deaf (LIBRAS), applied to an electro technical glossary (see Fig. 1).

The bones of the model are constrained to the moving markers by Blender, shown as dots on some of the panels. This method is used to animate the model and make the avatar. This procedure has many steps and takes a considerable amount of time. However, we solved this by putting almost all the commands used in the procedure in a python script that can be run from the Blender IDE.

The starting point for the current work was Vicon's DataStream SDK, which we are using to access the DataStream created in Vicon's Blade software. Our first tests on the data broadcasting performance by the Vicon system were based in the Vicon DataStreamSDK_CPP test sample application.

The challenge in streaming real-time animation over a network by treating data-streams broadcast from a remote location, is to increase the network performance. This is not an easy task; it depends on many factors, such as the type of technology used to access the server remotely (e.g., wired or wireless), distance from the modem, density or thickness of the walls, electrical interference, issues with the cables and so on. Furthermore, even if the client and server are in the same machine, hardware and software limitations may cause loss of frames – in our server, the log file shows that the loss is 50%, and using our Wi Fi connection, it is even worse and happens in a random way.

Since we are not supposed to deal with technical issues related to the client's environment, we decided on a solution that depends only on the server hardware and software performance, and so ensures that the maximum number of frames will be received by the client.

In order to accomplish this goal, we used an MS SQL Server Database Table and ADO components in a Delphi application to save the data sent by the Vicon DataStreamSDK C++ program. Of course, all of this could be done more efficiently using the same C++ program, but Delphi software development is much faster than C++, which is suitable for rapid and exploratory work.

The exchange of data between the two applications was performed using the Windows API's FindWindow function and COPYDATASTRUCT to send the data, and event handlers in the Delphi application to receive the data to be recorded into the database.

Once the applications are running, the clients are able to remotely connect to the database, read the fields from the table, process the data and animate the avatar, and this is straightforward in Python, the language used to extend Blender functionality.

Of course, with this method, we have a delay of the order of seconds, between the data acquisition and the avatar animation, but we hope that this will not be a big issue, compared to the benefits of having our avatar-interpreter performing where they are needed: in front of the client.

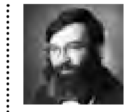
Fig. 1: Illustration of the methodology used to make the avatar-interpreter. Credit: A Benetti

VICON STANDARD

LITERATURE REVIEW

UNIVERSITY OF NEW BRUNSWICK

Having been asked to write a literature review as part of The Standard which celebrates Vicon having been active as a company for 30 years, I can't resist the chance to tell a little about my own connections to the company over that time.



BY ED BIDEN

I was involved in buying the first Vicon system at Childrens' Hospital San Diego in 1982/83 when the company was still part of Oxford Instruments. That first system had five cameras and ran on a Digital Equipment PDP 11-44 with a clock speed of 6 MHz and 1.25 megabyte of memory - hardly enough for a digital watch today. After moving to the University of New Brunswick we acquired a portable four camera Vicon 140 System in 1995, which was eventually replaced by a Vicon 512 and most recently by a T160 system, with 12 cameras, six force-plates, and an apparently limitless number of analog channels. Vicon has an interesting "Brief History" on page 28/29 for those who have followed the evolution of the product over the years.

In 1996, when I wrote my first literature review for The Standard, motion picture film was still in common use and is the method of data collection for several of the papers which were reviewed. At the time, a new entity "the web" was just beginning to become widespread and Google would not exist for another two years. By way of comparison, a web search of the terms "motion and analysis" found 50,000 references in 1996, and over two million today.

I re-read **Yang, L., Condie, M., Grant, J., Paul, J., Rowley D., "Effects of Joint Motion Constraints on the Gait of Normal Subjects and Their Implications for the Further Development of Hybrid FES Orthoses for Paraplegic Persons", J. Biomech. Vol 29 #2, 217-226 1996** and was struck that they were using a workstation based Vicon VX system with force platforms and EMG in a configuration not so different from what would be current. They were attempting to model quite subtle changes in gait due to the orthosis. In the same year **Kramers de Quervain, I.A., Simon, S., Leurgans, S., Pease, W.S., McAllister, D., "Gait Pattern in Early Recovery Period After Stroke", JBJS, Vol 78-A, pp 1506-1514, 1996** were using a Vicon system to answer the question posed in the title, but were also assessing whether or not representative strides were sufficient for gait analysis. Their work suggested that measuring simple variables over a few cycles and then focusing on the most representative cycle is an effective approach. This study would have been very difficult to do in the days of hand digitization of cine film due to the overwhelming volume of work required.

Fast forward to The Standard in 2012, **Wolf, A., Senesh M., "Estimating joint kinematics from skin motion observation: modeling and validation", Computer Methods in Biomechanics and Biomedical Engineering, 2011, Vol 14:11, pp 939-946** used a Vicon system to study the use of a large number of markers on either a rigid model of a forearm or on the forearms of volunteers. The objective was to apply a Kalman filter to the results in order to reduce the effect of skin motion. The idea of a Kalman filter is that if you have a situation which produces noisy data, you can improve the quality of the data by developing a model of the system being tested. As the data are collected they are mapped against the model predictions. In this case the filtering didn't actually improve on simpler techniques of low pass filtering and a point cluster method. However, comparing this to the papers from 1996 emphasises the enormous progress in computing power, and also in the Vicon hardware and software for imaging and point tracking, which allowed straightforward tracking of many markers on a segment rather than just a few. It is also worth noting that much larger camera arrays were possible and practical, which opened up new possibilities for motion capture and analysis.

Vicon systems can last a long time, as is evident in the paper reviewed in the 2012 Standard by **Hong WH, Chen HC, Yang FP, Wu CY, Chen CL, Wong AM. "Speech-associated labiomandibular movement in Mandarin-speaking children with quadriplegic cerebral palsy: a kinematic study." Res Dev Disabil. 2011 Vol 32(6): pp 2595-601**. Their application is to track facial motions, but the really interesting feature is they are using a Vicon 370 system, which must be close to 20 years old. Their experiments were on 12 children with spastic quadriplegia cerbral palsy and a matched group of unaffected children. They tracked facial movement while the children made various sounds, which were assessed by a speech pathologist. Using Vicon allowed both temporal and spatial coupling between the words spoken and the facial movements, and could be used to assist in planning therapy.

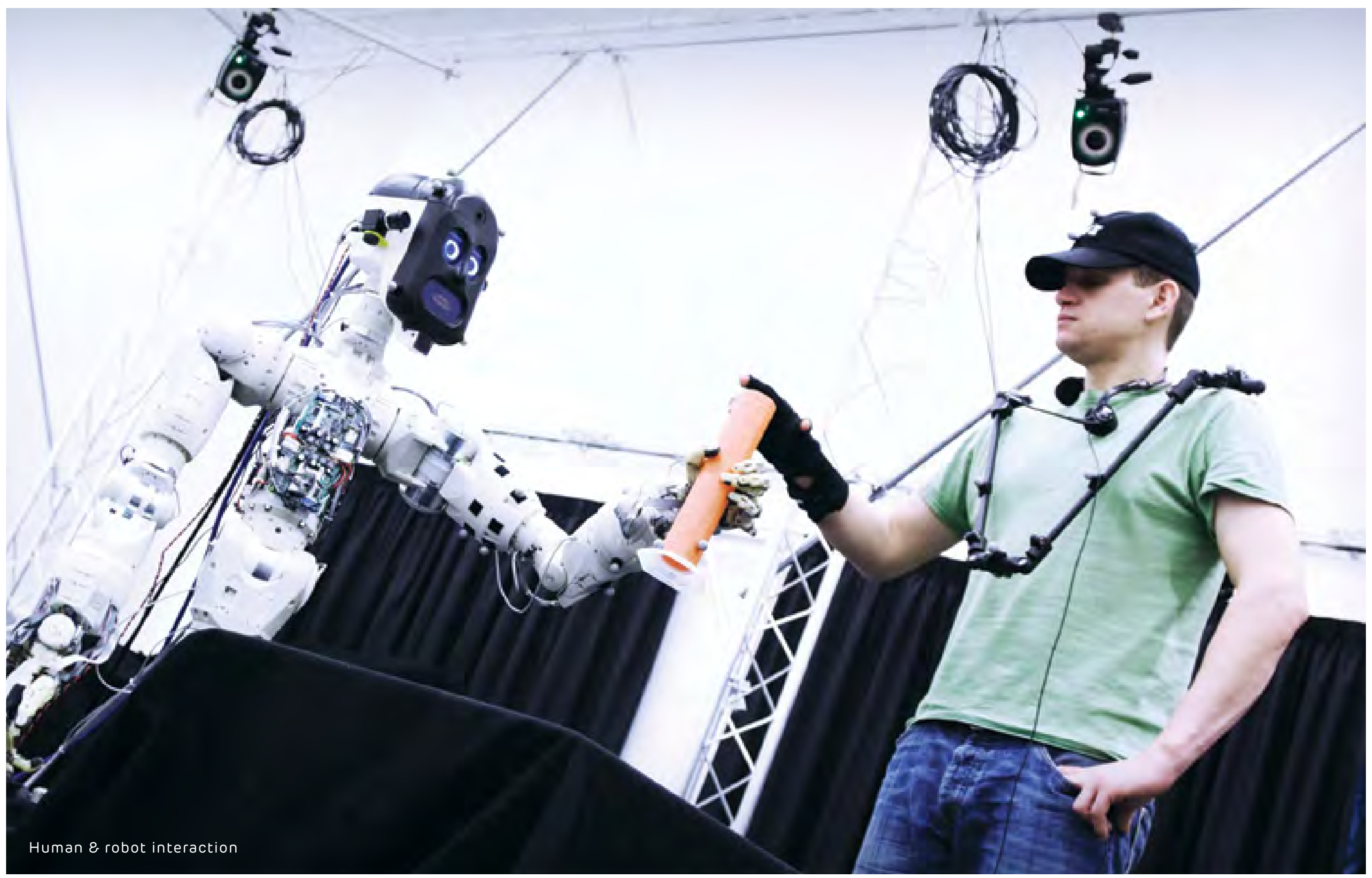
The next two papers are very recent ones and reflect applications of motion analysis in a health care setting with Parkinson's patients and in soccer. They both reflect that Vicon has become the definitive method of motion capture and analysis.

An interesting development over the past few years has been devices such as the Microsoft Kinect, which can track motions without the need for markers. **Galna B, Barry G, Jackson D, Mhiripiri D, Olivier P, Rochester L. "Accuracy of the Microsoft Kinect sensor for measuring movement in people with Parkinson's disease". Gait Posture. 2014 Jan 22.** The authors tested a Kinect system using Vicon as the "gold standard" to see if they could measure timing, gross motion patterns of things like rising from a chair, walking on the spot, and reaching, as well as fine motions such as hand clasping, finger tapping etc. Vicon can reliably measure all these types of motion. Kinect, which is a very inexpensive option, did well in overall timing and gross motion tracking, but didn't do as well in following fine motions. Vicon has established itself as a standard for motion measurement. The Kinect device may be the way that motion capture can move into a home or small clinic setting.

Another example of Vicon as a measurement standard is in the very new paper by **Stevens T GA, de Ruiter CJ, van Niel C, van de Rhee R, Beek PJ, Savelsbergh G JP. "Measuring Acceleration and Deceleration in Soccer-Specific Movements Using a Local Position Measurement (LPM) System." Int J Sports Physiol Perform. 2014 Feb 7.** They test a Local Position Measurement (LPM) system from Inmotio in a sports dome with a 10 camera Vicon T40S system concurrently tracking markers placed on the antennas of the LPM system while 12 male soccer players of average age 22 years, did moves which involved straight running in a 30x2m space, and running which involved direction change from 90 to 180 degrees in a 15x6m space. These are very large measurement volumes. Participants were tested at a "jog, sub-max, and max speed". The LPM was found to be quite accurate for the parameters measured and the role of the Vicon system was to act as the standard against which to compare.

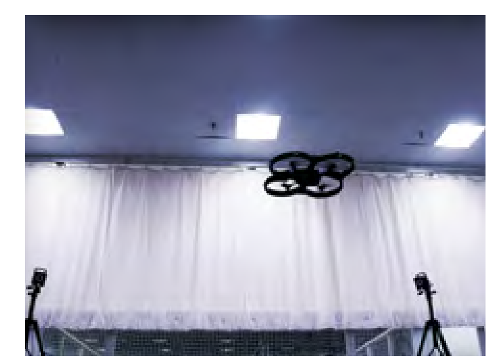
Vicon has had an amazing 30 years and is, without question, the defining system for motion analysis. The range of measurements which have been undertaken using this technology is staggering and the literature describing applications of these systems grows by the day.

BRISTOL ROBOTICS LABORATORY IN PICTURES


Human & robot interaction

Internationally recognised as a Centre of Excellence in Robotics, BRL is a state-of-the-art laboratory covering over 3,000 square metres.

It houses specialist workshops and wet labs, and two flying arenas with multiple Vicon systems. It is a unique collaboration that harnesses the collective strengths of its university partners, and brings together the best expertise from industry and the academic community to spearhead Britain's efforts to be a world leader in modern advanced robotics.



Bristol Robotics Laboratory, University of the West of England and University of Bristol

BY VICON EDITORIAL TEAM

Flying robotics

A newly commissioned 1900 sq ft flying arena has been instrumented with 10 T-Series cameras for research on the guidance and control of micro aerial vehicles. The goal of the research is to give vehicles autonomous navigation capabilities, so that they could be used for investigating damaged buildings or other hazardous, cluttered environments. The Vicon equipment has so far been used to support developments on autonomous decision making, real-time trajectory optimization, control and visual navigation.

Human & robot interaction

Bristol Elumotion Robot Torso Version 2 (BERT2) is a humanoid robot developed at Bristol Robotics Laboratory (BRL) in collaboration with Elumotion. BRL is working on the integration of several advanced subsystems within a heterogeneous computing infrastructure. This enables them to construct a unique platform ideally suited to investigate complex human-robot interaction (HRI). BRL is focusing on two important domains of non-verbal communication, namely gaze and pointing gestures in a real-world 3D setting.

QUANTIC DREAM DOUBLES ITS INVESTMENT IN VICON

TO DELIVER 'OUTSTANDING' PERFORMANCE CAPTURE

T-Series upgrade increases full performance capture space by over 200% helping Quantic Dream achieve more with less technology.

BY VICON EDITORIAL TEAM

World renowned games studio, Quantic Dream, has invested in 38 additional T-Series T160 cameras. Having previously enlisted Vicon technology for PS3 exclusive titles, Beyond: Two Souls and Heavy Rain, the recent investment will enable Quantic Dream to execute future high-profile projects in a larger full performance capture (FPC) space than ever before.

The upgrade more than doubles the available FPC volume, increasing the space from 3x4x3m, to 6l x 4w x 3h. Guillaume de Fondaumière, co-CEO at Quantic Dream said: "For any project, we usually require a mix of body mocap and full performance capture. Previously, this would mean having to create a new wall of trussing to mount the cameras into a smaller volume and re-configuring the system. This could take anywhere up to five days every time we needed to switch between the two set-ups. Our new system enables us to keep all the cameras on the same rig, meaning we can quickly and easily switch between body and full performance capture saving days of production time."

The newly equipped studio is now capable of both full performance capture for at least eight people and body capture at any time, providing Quantic Dream with a flexible and cost-effective solution. Vicon's extensive pre-consultation work at the site ensured that the new studio fulfilled all of the requirements laid out by Quantic Dream in maximising the full potential of the space and providing industry proven, production ready data through the integration of Vicon's data processing and capture tool, Blade 2.

Fondaumière continues: "The challenge for us was guaranteeing a quality full performance capture rig for our studio space. The Vicon team used their knowledge and expertise to design the studio and delivered over and above what we expected to achieve with fewer cameras than we thought possible. We are truly amazed at the results."

Imogen Moorhouse, CEO at Vicon commented: "Quantic Dream are a longstanding and innovative customer; so it was exciting to be challenged by them to deliver increased efficiency. We're delighted to have provided them with a studio that fits all requested purposes and exceeded their expectations. Quantic Dream's further investment in the T160, in combination with Blade 2, is testament to the camera's data quality and power and the software's reliability and production ready toolset."

Technical breakdown:

New system
Camera count: 76 T160s
New body capture volume: 11m x 6m x 3m
New Performance capture volume: 6m x 4m x 3m
Talent count for PC stage: at least eight actors

Previous system
Camera count: 64 – 36 T160s and 28 MX40s
Previous body capture volume: 11m x 6m x 3m
Previous performance capture volume: 3m x 4m x 3m
Talent count for PC stage: four actors

OBITUARY – PROFESSOR JOHN PAUL

Professor John P Paul died on 13 November 2013, aged 86. Although his seminal work on gait analysis was undertaken a few years before Vicon first came into existence, his influence was key to its beginnings and continues to this day.

Ask anyone unfamiliar with biomechanics what the load through the hip joint might be in someone walking. If they hazard a guess, it is probably that it is roughly equal to their weight. If they're really thoughtful, they may estimate it to be body weight less the weight of the leg they're standing on.

In the 1960s, this question took on a new urgency. Several pioneering orthopaedic surgeons began to replace badly worn or fractured hip joints with artificial replacements. The results were mixed. Although arthritic pain was generally relieved, depending on their design and materials, the artificial joints frequently came loose, caused fractures in the surrounding bone, sometimes fractured themselves, or wore rapidly away. It was clearly time to seek some engineering advice.

Verne Inman, the Berkeley titan of gait analysis, had in 1947 published estimates of hip joint load as over twice body weight. His estimates were revised and updated in a static anatomical model by McLeish and Charnley. Two other experimentalists took up the challenge of estimating dynamic hip joint load. In Sweden, Nils Rydell was able to measure the load directly in two of his patients in whom he inserted artificial joints with built-in strain gauges.

John Paul took a less invasive approach. In Strathclyde (Glasgow) he assembled a gait lab that we would all recognise today. He used antero-posterior and lateral 16mm cine film cameras, force platforms, and electromyography. Using measurements from this equipment, he was able to estimate hip joint load throughout the gait cycle, showing that, in someone walking vigorously, it reached a peak of almost three times body weight.

The main problem with JPP's experimental set-up was the time taken to measure kinematics from the cine film by hand. So he asked two of his research students, Michael Jarrett and Brian Andrews, to work on the design of an equivalent system, replacing the cine cameras by video, and the hand digitiser by automatic detection of retro-reflective markers. This prototype system, based on a PDP-10 computer, became operational in 1973.

Over the next five years, the Paul/Jarrett/Andrews video system was iteratively improved and replicated for installation in hospitals in Dundee and Oxford, as well as in Glasgow. In 1978, Oxford Metrics (formerly Oxford Dynamics) negotiated a license with JPP, by then Head of the Strathclyde Bioengineering Unit, to manufacture the system under the trade name Vicon.

John Paul's reputation as an elder statesman and strong advocate of sound engineering principles in biomechanics continued to grow until and beyond his retirement in 1992. He was a steadfast friend to Vicon and, as in all his professional dealings, one who spoke clearly and honestly.

JRWM
24 March 2014

Obituaries for John P Paul have appeared in the UK Times, Guardian, and Telegraph newspapers.

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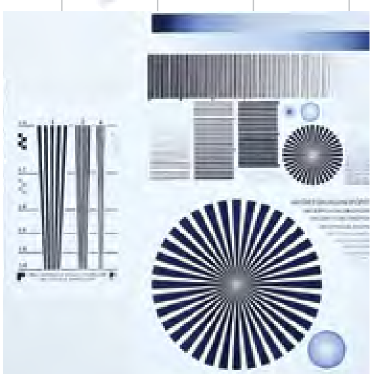

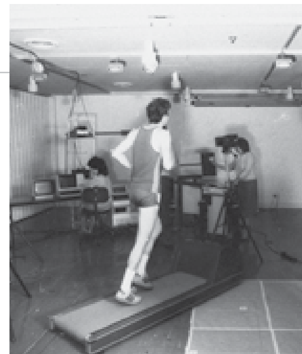

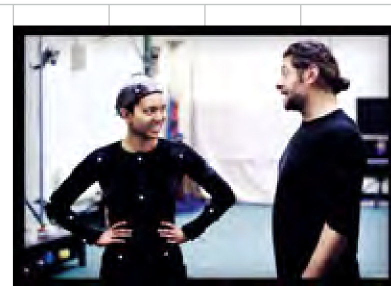

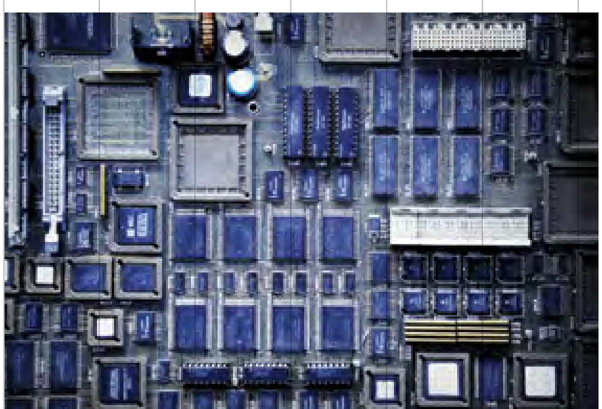

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