



**skillset**  
The Sector Skills Council for Creative Media

# THE CORE SKILLS OF

# VFX



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## INTRODUCTION

**THE CORE SKILLS OF VFX HANDBOOK HAS ONE SIMPLE, BUT AMBITIOUS AIM; TO IMPROVE THE NEW ENTRANT SKILLS AVAILABLE FOR THE UK'S VFX INDUSTRY.**

This handbook is of relevance to both students and tutors, learners and teachers. It has been produced following a sustained dialogue between Skillset, the industry and educators. This is a clear presentation of the VFX industry's voice on new entrant skills, setting out what skills the industry needs to remain world beating. It is designed to assist and enable universities and colleges to raise the standards and quantity of VFX courses available and thus the levels of new talent available in the UK. In turn, this will ensure our VFX industry continues to grow.

**We want to encourage new high quality courses and time is of the essence. By freely sharing the industry knowledge we have gathered in producing this handbook, we can accelerate the rate of change.**

Scott Pilgrim vs. the World  
Courtesy: Universal Pictures International (UPI)/Double Negative



Iron Man 2  
Courtesy: Paramount Pictures/Double Negative

## THE VFX LANDSCAPE

### WHY IS VFX SO IMPORTANT?

**We are exposed to the UK's VFX talent every day, from the films in the cinema to commercials, adverts and promos on TV. VFX is no longer the icing or gloss on a film or television production it is often integral to both story and style.**

The UK's VFX industry is not only world renowned but also strategically important to the future of the whole infrastructure of film production in the UK. Its quality work attracts studios to shoot films here too, since it is in their interest to maximise activity in the UK throughout the filmmaking process and VFX can be one of the highest earning areas of the filmmaking process. VFX was a significant lure for the \$920 million of inward film investment in 2010. A look down any list of US studio productions coming to the UK usually reveals at least one third having significant VFX needs.

There is a significant amount of iconic and award winning work done in the UK for worldwide blockbusters.

A sample of our industry's VFX in 2010 makes this clear: Harry Potter and the Deathly Hallows: Parts 1 and 2, Inception (winning both a Visual Effects Academy Award® and BAFTA for Double Negative), Captain America, John Carter of Mars, Scott Pilgrim vs. the World, Iron Man 2, Battle: Los Angeles, X Men: First Class, Pirates of the Caribbean: On Stranger Tides, The Chronicles of Narnia: Voyage of the Dawn Treader, Clash of the Titans, Spielberg's War Horse, The A-Team and The Smurfs to name but a few.

Whilst there has been an increase in high end, big budget (\$100 million plus), VFX heavy features choosing to base themselves in the UK as a result of film tax relief, one shouldn't imagine our VFX industry is solely a by-product of subsidies and tax breaks.

VFX is one of the sectors that attracts international film work on merit, even when tax breaks aren't possible. This is partly because of capacity - the Soho cluster of big VFX houses often share work, distributing shots between each other and thus enabling UK provision to expand and shrink to demand.

However there is a problem with this picture. Expansion depends on a greater pool of new talent. VFX houses are increasingly turning their attention abroad for some of the talent they need, but this can only ever be limited. As the industry has grown, there has not been a commensurate growth in the quality or number of UK graduates to feed it.

### THE CHALLENGE

**The challenge to both industry and education is to work together towards a common goal – to create a new landscape of VFX tuition, ensuring the industry's voice is embedded at the heart of the curriculum.**

Through a long consultation process, our VFX industry has told us what they need. It has placed a premium on the appropriate depth of skills and the centrality of teamwork in an industry that is increasingly specialising with new roles and functions developing all the time.

What's more, in a fast moving industry, time is of the essence. To wait for more quality courses to emerge is not an option. We need to kick-start growth in VFX training and education. And we need to start now.

At the same time, higher education has made it clear that one of the challenges it has is collecting this new knowledge and creating a structure to support it. The creation of new courses can be a long process.

That's where Skillset comes in. With the industry's assistance we can nurture emerging talent by seeding the growth of new industry-facing courses. We can accelerate the profusion of new high-quality courses by gathering industry knowledge and expertise and packaging it into a format that would be useful to our best educators, then disseminate this widely for free.

By providing such standards we would also be able to highlight and support the courses already out there that are doing great work in a tough educational climate.

Collating and communicating the industry's voice on new entrant skills in this handbook gives companies the opportunity to pass on relevant, high quality information to higher education without having to repeat themselves to many universities. Educators also have access to an authoritative body of advice and knowledge.

### THE OUTCOME

**Knitting the worlds of VFX and education together has proven complex. Skillset has worked closely with Ian Murphy, a consultant with both teaching and VFX industry experience, to consult with over 60 practitioners across the gamut of VFX. With over 1,000 hours of consultation with industry, including six major industry roundtables, we have discovered the important knowledge and competencies needed for a career in VFX. The result is a coherent modular scheme or ideal curriculum for the industry.**

We have developed a suite of 12 VFX modules, covering the breadth of the discipline that new entrants should be exposed to. These modules were designed to give higher education a useful prototype to help create their own programmes, or in some cases benchmark the programmes and teaching they already do. As a companion document we created a VFX Core Skills Primer for the student, whom we wanted to inspire and encourage to be ambitious.

# THE HANDBOOK COMPONENTS

## 1) THE VFX CORE SKILLS STUDENT PRIMER

**Our industry made it clear we should not only enable the trainer or educator, but also speak directly to the learner too. In every aspect of VFX skills there are a series of common core skills and knowledge that every new entrant should be armed with.**

In putting together this handbook it became clear these core skills needed to be written in a very different way - they needed to be both inspirational and aspirational, and delivered in short bites. We wanted this section to speak directly to students, as a guide they could frequently refer to throughout their course. The Student Primer essentially attempts to prepare them for the practices and challenges of the work environment.

The Student Primer needs to be seen as a complement or a blanket that encompasses and guides all VFX teaching.

Whilst the modules outline the disciplines and processes of different roles within VFX, the Student Primer provides an extra layer of guidance to the student, no matter what area of VFX they are specialising in. Its 24 points but these aren't edicts - they are an introduction to the work culture of VFX; invaluable for new entrants to internalise, live and breathe before they enter the workplace.

Many of these skills are what can be called soft skills, revolving around teamwork and communication, but as far as we know this is the first time they have been foregrounded and presented in this way specifically for VFX students. The information and context in the Primer is particularly valuable because it's the advice that is hardest to get in a university environment.

## 2) THE VFX MODULE SUITE

**The first point to make is to say that these modules are not really modules. They carry no credits and no-one has validated them. They started out as a convenient format with which Skillset approached industry with a series of questions. These are the kind of things that higher education needs to know, we said. The more we got answers the more we realised that these modules had a value to HE, as a mirror to hold up to their own teaching, or as a framework for developing their own modules.**

The modular conceit proved a convenient vehicle to frame the territory of VFX skills covered and how they

might usefully be compartmentalised. There is a logic to their demarcation and sequence, but we are aware it is not the only one.

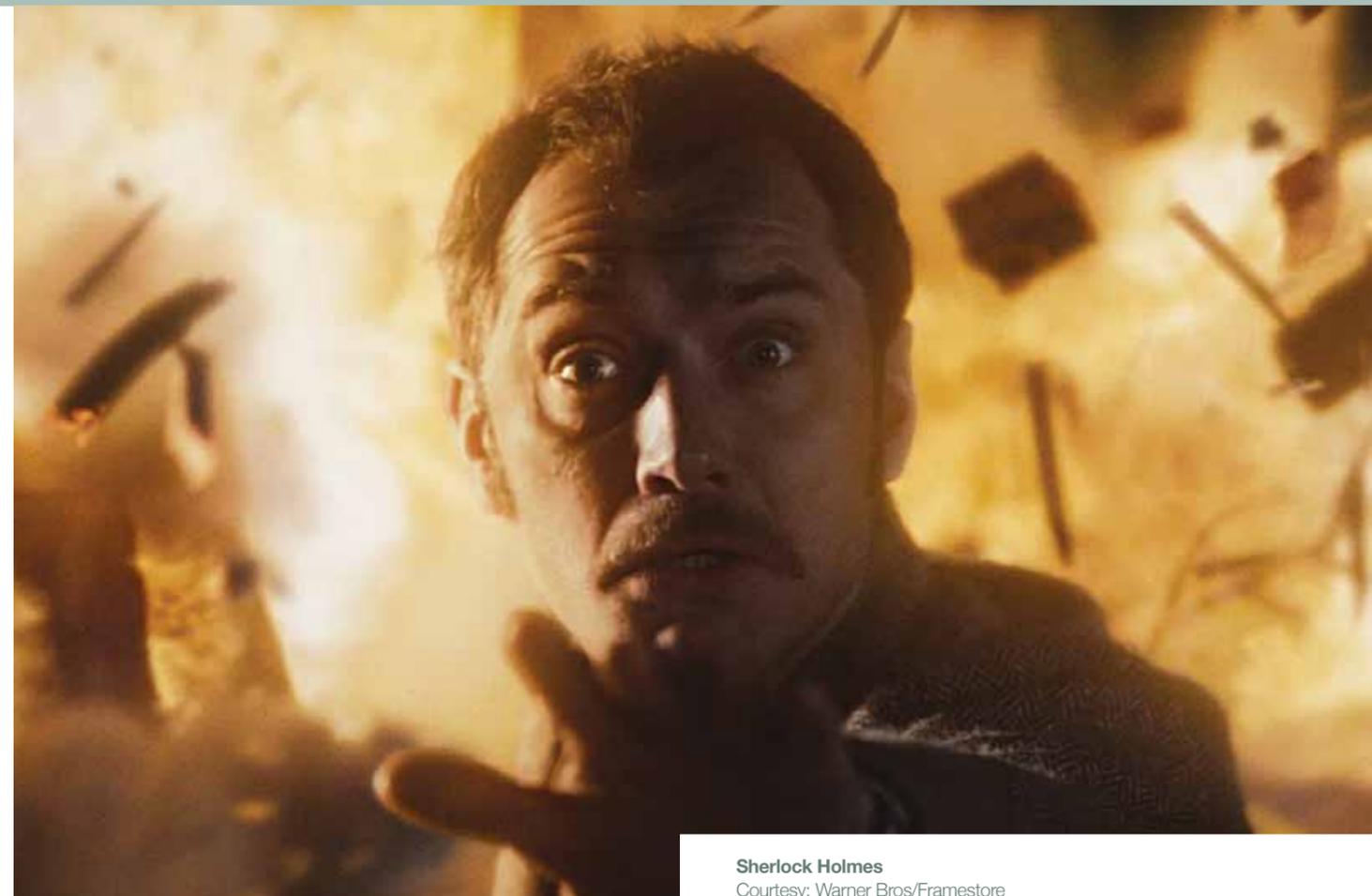
It is important to realise that these modules are a diagnostic tool that enables universities and colleges to do various things. Of course they can be adopted and embedded by any institution that has the ambition, but we are not dictating that anyone does this, nor that they take our aims and learning outcomes as verbatim. They are guides, suggestions. Institutions can choose to take one module or as many as they like and create curriculum, as the first step to creating new talent.

Alternately they may use them as benchmarks for existing modules or courses. How far does what they are currently doing measure up? How might they modify their course to better reflect the modules we have provided? Institutions are welcome to aggregate or break up our modules. They should digest whatever is appropriate for their locale, frameworks and structures. Each university should play to their strengths and resources.

Apart from the headings we have made no attempt to standardise the length or word count of these modules. That's because they have different authors and different voices, being products of roundtables held with specific professionals and each one has a different industry voice. The result is that some modules are longer and possibly more prescriptive than others; whilst some are packed with extra notes and comments that can lead the reader to further research. As such much of the material may be more raw, complex and direct than a normal academic module description, but that's the point - we wanted to capture industry's voice. Some educators will be bewildered by some of the language and terminology - a sure sign that institutions need to do further research and engage in industry consultation before they are ready to offer such modules.

With these modules we have created an industry gold standard for HE to follow, but we have also saved universities the time and resources it would take for them to identify and address the industry's urgent needs. At the end of the module suite there is a small addendum, the Teacher's Notes, that collects guidance we picked up along the way from our advisors. We could have easily expanded this section, but we know our colleagues in HE are the experts who will find novel and innovative ways to impart hard and soft VFX skills in the learning environment.

We want to free time up to allow universities to do what they are good at - to package knowledge and skills for the learner.



**Sherlock Holmes**  
Courtesy: Warner Bros/Framestore

## THE NEXT STAGE?

**Armed with the Student Primer and the Module Suite, our universities and colleges have a unique opportunity to create new and innovative VFX training and teaching formats.**

We know there is considerable interest from universities in creating new VFX courses and Skillset will help ensure that standards are high and courses are relevant for the UK's industry.

To encourage this, and with industry's backing, we will be creating a modular accreditation system which will revolve around how well universities reflect the substance and depth of these modules in their own curriculum. We have substantial industry backing for this, and this will ultimately be assessed by industry themselves.

However this will not be a numbers game based on how many modules any university may ingest. We imagine a varied topography where some courses will wish to add relevant modules to their existing animation, film or

programming courses, and others will build entirely new provision. To cater for this, we are working on a modular accreditation system and we hope to award and support a wide and varied landscape of courses. As such it differs from previous course-based accreditation schemes.

We are already working on a pilot with existing courses, and we have commenced a series of VFX awards to universities who are engaged in VFX relevant courses within our Skillset Academy Network and Skillset Accredited courses. It is our intention to utilise such an accreditation system to open up our support and awards to universities who successfully engage with teaching VFX industry skills.

For now the main focus is on enabling universities and colleges to create the new wave of talent that the UK's VFX industry needs. We hope this handbook will spark new relationships between industry and education as well as strengthen and support the best provision currently underway.

Harry Potter and the Deathly Hallows: Part 1  
Courtesy: Warner Bros/Cinesite



# THE VFX CORE SKILLS STUDENT PRIMER

If you are just starting to learn about VFX then this Primer is a good place to start.

## THE VFX CORE SKILLS STUDENT PRIMER

**IF YOU ARE JUST STARTING TO LEARN ABOUT VFX THEN THIS PRIMER IS A GOOD PLACE TO START. IT REPRESENTS THE VOICES OF OVER 60 VISUAL EFFECTS EXPERTS WHO HAVE SUCCESSFULLY RISEN THROUGH THE RANKS FROM COLLEGE OR UNIVERSITY THEMSELVES AND WHO WANT TO PASS ON THEIR EXPERIENCE AND ADVICE TO THE NEXT GENERATION WHO ARE STUDYING NOW.**

The aim of this Student Primer is to list the core skills that are universally useful across all VFX departments, companies and specialisms. It will dispel some of the common myths and give you advice on how to keep your options open and how to improve.

These 24 points represent important information and guidance to carry with you and consult regularly as you study VFX and start on your VFX career.

# 1. WHERE ARE YOU ON THE VFX SPECTRUM?

If you're looking for a career in VFX, it's a good rule of thumb that the bigger the company you want to work for (and you have done your research, right?) the more specialist the job roles are. Smaller VFX houses or commercial departments tend to require generalists - people who can model, animate and light, and can cover a range of functions to get the work done. Bigger companies may be looking for people who have more specialist skills - a real talent in a particular area. It's not a cut and dried distinction of course, but it's a good idea to think carefully about where your strengths lie along this spectrum.

Big VFX companies will often complain that they are weary of seeing a lot of generalist showreels that haven't got the depth in any particular area to be useful, or that they betray a lack of understanding of how teams work. VFX is a team sport - so it is important to remember from the beginning that you don't have to excel at every aspect of VFX production.

Many students tend to instinctively shy away from specialism, believing they need to dazzle prospective employers with a wide array of skills, thinking this gives them a greater chance of being employed. Most fall flat.

Displaying strong narrative filmmaking and cinematography skills is great, but if your work lacks the bedrock of decent modelling, animation, texturing, lighting or compositing skills it means you end up pleasing no-one. Don't let a showreel of a personal ten minute pet project film you created all by yourself highlight your weaknesses and smother your real strengths!

If you are a student interested in VFX try out different roles and specialisms across the whole pipeline whilst at college. **Find out what you are good at, what your strengths are and where they are on the VFX spectrum. Get the breadth of experience, but also taste the depth of specialism.**

Another way to think about this spectrum of talent is from the recruiter's point of view. The easier you can make it for the employer to know which particular area you're good at and whereabouts you are on the spectrum, the better the chance you have of being hired into the right role in the right company.

Relax, no-one expects you to leave college as an expert specialist, but it is useful for you to show larger companies which kind of work you may be best at. Are your skills more 2D or 3D, for instance? Employers like rough diamonds that have a little bit of shape already.

# 2. VFX IS A TEAM SPORT

To try out different specialisms, teamwork is the way to go. To be able to show evidence that you are a team player who has tried different roles is a powerful statement at any interview. Chances are you'll have a better visual product for employers to view, (a word of warning - be aware you'll need to explain clearly your contribution - it's quite possible the recruiter has seen other members of the same team, so will be keen to get a good idea of who did what - so no exaggerations please!)

VFX is created by a large team of individuals. A team player attitude will win you friends very quickly. As a member of the team, you need to do enough to any creative asset to ensure it is passed on to the next person to a standard that enables them to work efficiently and creatively too. Depending on the size of the facility, there may be a dozen or more people working on a single shot, and each one of them brings something of their own creativity to it. Get to know the rest of the people you're working with, and understand what they do and how you fit in to the bigger picture. Discuss the work with them, particularly with the people you're handing off to; what could you do to make their lives easier?



The Chronicles of Narnia: The Voyage of the Dawn Treader  
Courtesy: Twentieth Century Fox Film Corporation/  
Framestore/Prime Focus Film

# 3. VFX: WHERE EFFICIENCY AND CREATIVITY MEET

In order to understand the VFX industry and its operations you need to understand the underlying need for efficiency in image and data that is essential to making successful VFX.

When you create images or assets you need to complete the task to specification, not perfection. Perfectionists only slow the process down, because they can't let go. Frills and extras may get you noticed but will only be appreciated if you have the time to complete them.

Think ahead; in most VFX work it's important to get the overall foundations of the problem worked out and get some feedback on what you have done, before getting carried away with fine-tuning tiny details, or adding superfluous polish.

It's important to understand the detail and amount of work needed to successfully fool the eye and get the job done. This often means finding appropriate solutions within the parameters you've got, and not using technology for the sake of it. As an example, there's no point in using a processor-hungry particle system for a

shot that features fog in the distance if shooting dry ice with a video camera will do the job. And there's no point in creating a complex simulation of a simple building falling down, if a crafty animation will do the job more data-efficiently.

It's important to remember it's not about reproducing the real world in 3D but mimicking it. Cheat creatively where you can to save processing power and rendering time, using 2D images, painting, baking lighting and occlusion into textures, or rendering separate passes. You don't need to model the back of objects if the camera isn't going there!

Work with simplicity in mind - you need to recognise that people often try to fix problems by adding more complexity. For instance, if your CGI lighting doesn't work, it's tempting to add another light, but this may have negative repercussions later down the pipeline. Being able to plan effectively before beginning a project is a skill to develop no matter what software you are using.

## 4. ITS NOT ABOUT YOU, IT'S ABOUT THE PIPELINE

VFX at scale is about pipelines not single software solutions. Your work often slots somewhere into a chain consisting of a multitude of complex tasks carried out by many others. What you do ripples out and has repercussions beyond just the next person in the pipeline.

So it's great to have an overview of the whole workflow; you'll win friends higher up the food chain by passing on work that is efficient and doesn't leave them with headaches because you've second guessed certain issues or pitfalls. Understand your contribution to the whole pipeline and what you need to deliver to make it work.

To progress in the VFX industry you will also need to learn to build your own elegant work solutions that allow for the last minute changes that you will inevitably be asked to perform, so that revisions can be implemented quickly.

Think about the final picture, how big and how long your element will be seen and engineer appropriately.

## 5. DEADLINES ARE REALLY DEADLINES

It's not like college where some deadlines can be stretched or deferred. You'll gain the respect of the whole team if you are dependable and hit your deadlines.

It's important to realise you can't work on any product to the level of perfection you might think it deserves; there'll always be room for improvements, but that's not the point. Keep things simple. The encroaching deadline always trumps any work completed to your own level of perfection. Doing what's needed so the shot works is essential.

It's useful to have a Plan B if things don't go to schedule. What can you jettison to get the task done at the right quality? What are the shortcuts you can take? Can you use less textures or simpler shading?



Harry Potter and the Deathly Hallows: Part 1  
Courtesy: Warner Bros/Framestore

## 6. SOMEWHERE, THERE IS A CLIENT

In this industry it's about getting the shot right for someone else, not for you, and you need to be professional about it. You are working towards a client's satisfaction, usually communicated through your line manager. This doesn't necessarily mean your work is heavily prescribed - there can be great interpretation involved and much leeway for the artist.

Completing the brief to the client's satisfaction trumps any work that you may personally think is fantastic or finished.

At the end of the day VFX is a service industry. You have been commissioned to produce work for a client, and you are being paid to deliver that. If the client doesn't like what you have produced, it's usually down to personal taste or the need to fit in with other shots in the film. Don't take it personally!

In certain companies there is a skill in second guessing and pre-empting the clients future comments or requests. They need to feel it is their vision, realised through you.

## 7. CRITICISM IS A REQUEST FOR CHANGE

Many new entrants find it hard to take criticism, because at university criticism is often shielded or cushioned and usually lacks commercial imperatives.

It's better to accept criticism as requests for change and not a slur on your abilities. Taking and adapting to criticism positively and dispassionately is of prime importance so leave your ego at the door.

Don't get attached to shots or think you'll gain brownie points for needless embellishments. Part of this is accepting there's no right way to do a shot and your pet approach may not be the one required. There are always a few ways to achieve a finished shot and it's your line manager's call.

Don't get attached to a certain solution or a particular shot. It could be brilliant and yet still be cut from the film.

The actual edit of a film is sometimes evolving as the VFX are created and this means certain shots may not be used.

Incidentally, in large VFX organisations you are appraised by HR on how successfully you respond to criticism and requests, not extra flourishes or personal touches. Straight feedback and hard truths are the most direct way to get your work done, so don't expect diplomacy, there's no time for that.

## 8. EXPLAIN YOURSELF

Get used to the idea of presenting your work. In a large team you may go to 'dailies' sessions, and smaller teams may involve desk based review sessions. It is important in these to speak up and describe what you have changed since the last time the client/supervisor saw the work and what decisions you have made on the way. You need to explain yourself and the strategy you are using to nail a certain shot, the journey you are on and where you are going. Giving those around you progress on what you have done so far and how you will proceed, allows them to have faith in what you are doing.

Don't be afraid to speak up to your supervisors during review sessions. If you have ideas on how to make the shot look better or get it done quicker then say so, but don't take it personally if they want to take things in a different direction. A supervisor will be seeing a large number of artists and shots and there is a certain amount of selling your work that you have to do.

Being honest pays. It's human nature to try and cover up or ignore problems, especially if you think others will be judging your ability to do the job properly. In VFX small problems easily snowball into huge issues as they pass through different departments and you need to understand that there'll be trouble further down the line if you don't communicate now. It's VFX karma.

Also, be honest with regard to estimating time. A supervisor or other team member needs an honest overview of how long something will take in order to structure all other aspects of a shot/sequence/show properly. If you've got two days but you think it'll take four, tell them. They'll be much happier if you're honest so they can draft in some help and still hit the deadline!

Remember everyone makes mistakes and new entrants of all people aren't expected to be the perfect, finished article.



Harry Potter and the Deathly Hallows: Part 1  
Courtesy: Warner Bros/Framestore

## 9. VFX AND THE PHOTOREAL

VFX is often about creating photoreal imagery, but only within the context of making the image believable and familiar within the world being portrayed. Gollum, Dobby, Davey Jones or Optimus Prime are believable because we feel they are photoreal within the world they inhabit, not because we've seen guys like them in the high street.

Believability is the key. A variety of image assets have to be integrated so they seem to conform to the same physical laws no matter how bizarre the juxtaposition. It all needs to look like it was shot in the same camera. This not only means you need to understand the visual and motion cues that make something believable, and the tell-tale elements that deny an image's believability, but also you'll often need to draw on a vast array of cultural references and the 'collective imaginary'. For instance, we all have an idea of what a fairy castle or a fire-breathing dragon needs to consist of, even though we've never seen one. Everybody carries an image library in their head of culture references, and you'll need to tap into this from time to time.

It needs to be remembered most VFX only succeeds if it is invisible, and we don't know it's there. A film like the King's Speech made extensive use of VFX without being intrusive - 140 VFX shots took 4 months to complete in post production.

## 10. THAT DOESN'T LOOK RIGHT!

**Realising what works visually and how to mimic it are core skills across VFX. Why does something look real or 'right', and what factors are involved? Sometimes we see pictures on screen that instinctively don't look right, and this can have dire effects when watching a film. Suddenly we opt out of the illusion and become hypercritical.**

Mimicry starts with observation. You should start by scrutinising and analysing natural phenomena. Light, colour, perspective, the physics of the everyday. The great thing is you can do this anywhere; look out the window and see how shadows fall off, colour bounces, distance gets hazier.

Secondly, why do certain scenes or shots create an emotional impact? How does the use of light, colour, perspective, and other elements denote emotive conditions like fear, security, happiness? Being a good artist means using these skills to improve the shot rather than waiting for someone else to point them out to you.

Use your eyes before you use your computer!

## 11. PLAN AND DECONSTRUCT

**Being able to dissect both shots and tasks into constituent steps or elements is a highly prized skill that needs to be worked on.**

This methodology is invaluable in many new entrant jobs like rotoscope work. If you impetuously set off roto'ing from frame one, you would soon come undone. On the other hand it would lessen your workload enormously if you went through the shot and broke it down into a series of overlapping shapes that led to more automation and less individual frame by frame manipulation.

So, dissect your workload, break into logical steps, but if you unexpectedly end up in a dead-end, fixing fix after fix, don't be afraid to start again!

## 12. THE BEST VFX TOOL IS PAPER

**Why not plan things on paper before you start? This can help you get your ideas composed and help you figure out tasks before you get too bogged down in technology.**

This approach will help with problem solving, and learning how to dissect tasks into stages, thinking ahead. There's no-one correct approach to VFX problems - just ones that may be more efficient than others. It's easy to jump straight into the software and get lost in a piece of work because you didn't think about what was going to happen later.

Can you draw? That old low-tech medium of life drawing is a good starting point for many jobs in VFX. Learning anatomy, musculature, weight, articulation - there's nothing like it if you want to progress in 3D.

## 13. DON'T WAIT TO BE TAUGHT

**A VFX world tends to be a freelance world - so be aware of technological changes and keep yourself up to date as you go.**

Be self-motivated, and don't expect in-house training (although plenty of places do it) to solve all your training needs. Keep in touch with developments in your chosen field, through magazines, internet forums and blogs, software documentation, company websites, even SIGGRAPH and conference papers.

## 14. YOU'RE SURROUNDED BY EXPERTISE

**As a new entrant you shouldn't be scared to ask questions or admit you don't know something! Be forward - get information from others when you need it, instead of trying to hide what you don't know. It's not embarrassing to ask for information twice if you didn't get it at first. Your enthusiasm will be noted, and your work will progress faster.**

It's often useful to get to know different departments at work, and to talk to those either side of the job you are doing, to get an idea of what they need if you're not 100% clear.

Get to understand who around you has knowledge and expertise that you can tap into in order to get the task in hand done as quickly and efficiently as possible. It may be your line manager, or maybe the person who's been working there for a bit longer than you. Ask respectfully and be sensitive to their workload - disturb them too often and the goodwill may disappear. Always read the manual or research problems online first.

In certain companies there are leaders or department heads whom you need to follow. Identify those with greater experience, and use them as role models without bugging them!

## 15. THE VFX LEXICON

As with any discipline or sector, there is a shared language across VFX companies that enables clear communication of concepts and day to day processes.

Get to know this glossary of acronyms, technical terms, film language, camera and film set jargon (so what is the difference between zooming and tracking in?), IT language, and slang. If you want to be in the VFX gang, you need to learn the lingo!

## 16. VFX IS CINEMATOGRAPHY AND MATHS

Essentially, and often intuitively, you need a basic awareness of cinematography and/or maths and logic. If you are not interested in films or curious about how what you see on a screen is achieved, or don't enjoy analysis, opinion and deconstruction of the same, VFX might not be for you.

It's useful to also have a similar appreciation of photography and painting, from which you can learn composition, balance, chiaroscuro, framing, implied motion and other concepts. Photography can help you observe and frame what is real and painting can help you appreciate what it takes to replicate and suggest reality.

## 17. YIKES, WHAT KIND OF MATHS?

If you're an artist don't worry, this isn't essential (just as life drawing isn't for a programmer) but an appreciation of what each other needs to know will help you bridge the artist-techie gap. It's really about thinking logically and mental arithmetic.

Our advisors especially stressed trigonometry, but also matrices, vectors, applied mechanics and basic algebra as examples of what is useful, as well as basic scripting.

A bit of knowledge about physics will help with 3D particle systems too.

## 18. KNOW YOUR TOOL: THE COMPUTER

Computer literacy with UNIX/LINUX is essential in today's VFX house to the level of a working ability to navigate, rename, launch applications, move files, safely delete, understand and use symbolic links (shortcuts), and be able to configure your environment to suit the show and/or shot you are about to start work on.

In some roles it is desirable but not essential to have a working knowledge of Python, C/C++, or other forms of scripting and programming.

Some suggest a brief understanding of the components of a modern computer - the CPU, GPU, graphics card and their properties and a firm understanding of your local drive and its relationship to a server or network. Hopefully you know where your wallet or purse is - but do you know where your images are? They are just as important.

It's not just a case of knowing where your files are, but what they are called. They need to correspond to the file naming conventions of your workplace. Idiosyncratic names may make sense to you, but not to colleagues who need to use your work later. You'll need to appreciate the importance of naming protocols and conforming to them, how versions are named and building project folders and directories now to allow revisions and changes in the future by someone else. Different workplaces have different ways of doing this, but at the heart they are all crucially important. It's vital to avoid the implications of incorrectly labelled, named or stored files and the potentially costly and catastrophic consequences of poor file management.



The Chronicles of Narnia: The Voyage of the Dawn Treader  
Courtesy: Twentieth Century Fox Film Corporation/  
Framestore/Prime Focus Film

## 19. FILM THEORY

Film theory can be really useful if you can apply it to practice. Awareness of how narrative structures and cinematic grammar impart meaning can be useful, although no-one's going to give you a job solely because you can quote Bazin or Žižek.

Look at the shots and cuts in films at the cinema; why do they work? How are the colour and lighting references working to promote the story? How are your emotions manipulated through imagery?

## 20. VFX IS NOT NEW

It didn't start with Star Wars. VFX has a pedigree stretching back into early photography. Like any discipline, you can learn from the past.

A sense of pre-CGI VFX history and context can help understand where we are now, culturally as well as technologically, and can open new insights into current practice.

## 21. THE ART OF THE EDIT

Although your work in the industry is usually shot based (so you are removed from the wider view of the sequence or scene you are working on, or how it might fit into the story arc), a knowledge of the principles of editing (note: we don't mean editing software) will stand you in good stead as you progress through your career.

Having a feel for how the construction and pace of different shots can engage a viewer and imbue tension or meaning is a bankable skill.

It will also help you appreciate the job of editorial staff within the VFX workflow and how shots you have been working on can suddenly be modified or dropped.

## 22. STYLE AND VISION

VFX is proliferating, and not everyone wants to work on a small section of a film time after time. There are plenty of indie filmmakers, animation directors, motion graphic designers, even games artists using VFX techniques and software to achieve amazing images and styles.

If this is your path, start to work on your own style and develop a look or signature. For commercials or promos, clients often want vision, ideas and stylistic flourishes. However stay adaptable as styles can become dated and outmoded.

## 23. OPTICS

VFX is experienced through an organ with particular foibles, limitations and properties - the eye. Understanding how the eye works, how it can be fooled and even directed to certain areas of the screen, is useful.

How our brain interprets light that enters the cornea is a subject in itself. The brain is a complex thing but an experience of optical illusions will quickly give an idea of how visuals can be misinterpreted. As an example colours and tones can appear different depending on other colours that surround them. You can see this in visual tricks like the Cornsweet or Chubb illusions. It's an important thing to understand for lighting, compositing and for matte painting.

A little research into how we see won't go amiss. But they do mean a little. It's not like you can trade-in your eyes for a better model.

## 24. SURPRISE US

The history of VFX is still being written, and relies on new talent to surprise us all. VFX has been surprising us since Alfred Clarke's stop action beheading of Mary Queen of Scots in 1895, through Melies, Murneau and Lang to O'Brien's King Kong, Harryhausen's fighting skeletons, Trumbull's gravity free atmosphere in 2001: A Space Odyssey, technical innovations from Ed Catmull and Alvy Ray Smith, through Tron and Star Wars into the digital era with John Gaeta's bullet time and John Knoll's Avatar.

But there are other low budget surprises too. Startling work like Uruguayan Fede Alvarez's Panic Attack, Alex Roman's The Third and Seventh or Gareth Edward's Monsters point the way to a new emerging VFX indie culture, beyond Hollywood studios and the mass global audience. We look forward to what today's VFX students will create tomorrow.

Now it's your turn to surprise us.



The King's Speech  
Courtesy: Momentum Pictures/Molinaire

Courtesy: ©The Mill



## THE VFX MODULE SUITE

These modules were developed through industry consultation and designed to explain the skills needed to work competently in a range of roles in the VFX industry. These are non-prescriptive templates or guides for universities and colleges to adapt or adopt. They are a powerful aid to starting new courses, or comparing current ones.

## THE VFX MODULE SUITE

**THE MODULES CARRY NO CREDITS AND NO-ONE HAS VALIDATED THEM. THE MODULE TEMPLATE PROVED A CONVENIENT VEHICLE TO FRAME THE TERRITORY OF VFX SKILLS AND HOW THEY MIGHT USEFULLY BE COMPARTMENTALISED. THERE IS A LOGIC TO THEIR DEMARCATION AND SEQUENCE, BUT WE ARE AWARE IT IS NOT THE ONLY ONE.**

Institutions can choose to take one or many modules to create curriculum. Alternatively they may use them as benchmarks for existing modules or courses. Universities should digest whatever is appropriate for their locale, frameworks and structures. These modules are a means to empower universities and colleges, not dictate to them. Each university should play to their strengths and resources.

We have made no attempt to standardise the length or word count of these modules. That's because they have different authors and different voices, being products of consultation with specific professionals. Some modules may be more difficult and more prescriptive than others. Much of the material may be more raw, complex and direct than a normal module description form, containing a mixture of commentary and suggestions that tutors may find useful. Comments and notes are embedded in the text in italics to give useful hints, opinion and suggestions.

Through the dissemination of these modules we hope to accelerate and initiate more quality courses to feed the UK's VFX industry.

- 001: ACQUISITION FOR VFX
- 002: CGI FOUNDATION (STILL IMAGE) FOR VFX
- 003: FOUNDATION IN VFX COMPOSITING
- 004: THE MATTE
- 005: VFX PAINT AND RIG REMOVAL
- 006: 3D MATCHMOVING FOR VFX
- 007: MATTE PAINTING AND ENVIRONMENTS FOR VFX
- 008: RIGGING AND CREATURE EFFECTS FOR VFX
- 009: DIGITAL SCULPTURE FOR VFX
- 010: CGI ANIMATION FOUNDATION FOR VFX
- 011: EFFECTS ANIMATION FOR VFX
- 012: CGI LIGHTING AND LOOK DEVELOPMENT FOR VFX

Courtesy: National Film and Television School, A Skillset Film & Media Academy



# ACQUISITION FOR VFX

This module introduces students to where the imagery and data they will be working with in VFX originates and how the VFX professional might be involved at early stages in ensuring that data and imagery is captured and formatted correctly, ready for later use.

## MODULE 001: ACQUISITION FOR VFX

### 1. MODULE DESCRIPTION

**This module introduces students to where the imagery and data they will be working with in VFX originates and how the VFX professional might be involved at early stages in ensuring that data and imagery is captured and formatted correctly, ready for later use.**

By understanding the mechanisms and technologies involved in image and data origination, students can gain an appreciation of how such processes can give imagery certain qualities or even distortions that the VFX professional will need to address later.

**This module particularly examines four main sources of imagery and data:**

- Principal photography (the lens and the physical properties of the particular camera used on set).
- CGI and data (generated imagery and data).
- The motion/performance capture process.
- Editorial (the sequences and their construction parameters as dictated by the client).

### 2. PRE-REQUISITES

None

### 3. SUGGESTED CO-REQUISITES

- Cinematography/photography
- Hard body modelling
- Lighting and look development
- Compositing

### 4. AIMS

**This module aims to:**

- Equip students with a background understanding of where the imagery and data they will be dealing with in their professional lives originates from.
- Ingrain in the learner an understanding of the importance of file formats, planning, and robust workflows.
- Give students an appreciation of the particular qualities and properties of certain media processes.
- Give an awareness of how lenses, compression, storage and other factors can stamp their own unique qualities onto images.

### 5. LEARNING OUTCOMES

**On completion students will be able to demonstrate:**

- A broad understanding of the origination of different information and how it is gathered, stored and modified.

- That they can recognise key issues regarding creating images and data and how VFX personnel might be involved in the early stages of such creation.
- A first hand experience of a shoot, a mo-cap exercise and/or file transfers and naming.
- An understanding of techniques for shooting a correctly exposed screen.
- Practical elements that show the student has negotiated issues of modifying, cleaning up or packaging imagery or data professionally.

### 6. OUTLINE CONTENT

This module examines four areas where most of the images and data we deal with in VFX originate.

**PRINCIPAL PHOTOGRAPHY** (lenses and the physical characteristics of the particular camera used on set)

*Whilst VFX personnel increasingly get involved earlier in the production process, it is important to realise that the camera department rightly dictates and leads during principal photography. VFX has very little or no influence here. However, the characteristics of the camera used will often need to be recorded, replicated and applied to CGI 'in post'. This may involve much observation and creativity on the part of an individual artist or even software tools being written by a pipeline TD, for production-wide application.*

Thus, this section of the module may look at some or all of the following:

What does the lens do - exposure, aberration, motion artifacts, depth of field, flare, blooming, veiling, distortion etc.

.....  
The concept of persistence of vision and motion blur.

.....  
What does the camera format lend to the image? How would you replicate such characteristics and apply to other CGI elements later in post?

.....  
How is the camera position moving in the shot and how might you record its position so you can apply it to a 3D CGI scene later?

.....  
Nodal vs non-nodal vs mixed positioning.

.....  
The Curve, Cineon (log) data, colour space as it applies to camera.

.....  
Getting a noise reference (lens cap on).

.....  
The need and use for a colour reference for the plate - the Macbeth chart - shot for each plate, allowing colour ranges to be matched.

.....  
The need for and use of a lens grid for each lens used in order to gather distortion info metadata from lenses made by

# MODULE 001

certain manufacturers (e.g. Cooke). Position, gimbal, focal length and how it is recorded, read and later used.

New possibilities with zoom and focus encoders – camera bolt-ons.

How to light a screen, how to judge the exposure of the screen through the use of spot meters and digital SLRs. When to choose blue vs green. Dealing with creases, joins, shadows, light falloff etc.

## CGI AND DATA (generated imagery and data)

Various real phenomena and natural processes inform the eventual creation of CGI imagery. This module section concentrates on those related to gaining a) lighting references, b) geometry references and c) motion or positional data for a virtual camera which will eventually 'film' CGI elements.

The role of witness cameras, and how they create an accurate virtual camera (especially as a solution to real camera occlusion).

Motion reference cameras (e.g. simple camcorders) should be explained, or used on a shoot.

How you mark and measure the set, for instance theodolite surveys for 3D, especially with the intention of CGI extension work later.

Capturing references for later CGI lighting. It is important you understand and later replicate the DoP's lighting scheme.

Capturing light reference typified by the grey (for diffuse light) and chrome (for direct light) balls, which are shot in situ.

Image-based lighting for HDRI. HDR capture: capturing via chrome balls shot at different f-stops, or a Spheron camera shooting a panorama from a single point. Stitching stills taken at 10 degree intervals to make a panorama.

Collecting texture and other visual references from the set, for use by texture and environment artists. The importance of capturing using the wider range of the digital camera RAW image format for HDRI and textures.

Tracking markers are used for creating an accurate virtual camera, OR are applied to objects in frame to attach CGI elements. Examples may be talking animal muzzles or vehicle embellishments. As such the tracking markers size, position, type and how they are used on green screen shoots, with c-stands or other objects need to be explored to allow for enough depth analysis for a 3D matchmoving application.

Under this module section students should be exposed to three levels of engagement with the recording of data:

### i) DIY means: using photos and hand measurements

The bare information you need without necessarily any automation or gadgets: lens type, chip size/camera

back, height, distance and other measurements or references (e.g. yardstick). Witness camera style stills for 3D matchmoving applications (depending on the application available), can be used to improve the camera solve. The student should understand how collected data/measurements are input into 3D matchmoving software and show that geometry can be constructed from point clouds generated within software. These should fit onto (and move with) the image, when overlaid – if the measurements were accurate!

### ii) Semi-automatic means

Demonstrating how stills shot for image based modelling/photogrammetry software, (e.g. PTrack, Imagemodeller, Nuke 6.2 upwards) will generate geometry/mesh or a point cloud. This is good for modelling buildings or extracting depth from relatively simple objects.

### iii) Automatic means

An explanation of LIDAR (used for large sets, buildings and large areas which would take too long to collect by other means) and how LIDAR generates geometry based on laser scanning technology.

### On Set:

This module should also include a who's who of a large contemporary film set. Who are your points of contact on set, particularly for camera.

Chains of command on film shoots - protocols and responsibilities.

What you can reasonably ask the camera department to do and the right time to suggest it.

How you can be proactive and helpful on set.

Communicating useful suggestions can save both you and others time. (e.g. "We don't need to do this shot with a large green screen, because we can do a garbage mask in post.")

### MOTION AND PERFORMANCE CAPTURE

*This is essentially a way of measuring moving things and applying that movement to drive CGI objects, characters and digital doubles. The history and uses of motion capture data should be outlined, but the module should focus on optical processes whilst referring to other mo-cap systems that are available. It is not necessary for the student to have operated a system, but it is essential they understand the process and the types of data they might be given and how to process it. A visit to a facility off-campus might be instructive.*

What can be captured, and what can't (eyes, cloth)?

Types of mo-cap system.

Roles in mo-cap work.

The process of planning a shotlist from a script - coming up with scenarios.

Working with actors and how a mo-cap shoot is directed.



Courtesy: National Film and Television School, A Skillset Film & Media Academy

Getting a good performance. Physical props and measurement.

Marker placement.

Tracking and solving.

Different types of solver.

Dealing with occlusion.

The role of the lens and calibration.

Understanding the relationship of data captured to a rig.

How to remove noise.

Range of motion and it's purpose. Degrees of freedom re: joints.

File nomenclature.

Facial Action Coding System (FACS) sessions, facial capture and rigging.

Blend shapes and deformers.

Motion edits and the importance of clean curves.

Real time mo-cap applied to a rig for a director to view.

Camera and motion capture techniques in the future (e.g. Cameron's 'Simulcam' on Avatar).

How to capture unconventional anthropomorphic movements (e.g. big feet/big head characters).

### UNDERSTANDING THE ROLE OF EDITORIAL

*The VFX editor or editorial department apportion out the shots and their constituent plates, providing a template or scaffold structure that many people build on and supply elements for to create the finished shot. As such they are another originator of imagery that the VFX student should be aware of.*

Anatomy of film production and the VFX vendor's relationship to the production.

The repercussions of marketing schedules and deliverables on the VFX schedule.

Closed/locked reels.

The nature of handles. You need to concentrate on the middle!

Talking to your supervisor or production assistants, predicting task completion.

Understanding editorial hierarchy and the relationship of VFX editors both on the client side and internally.

*In bigger companies you will be distant from editorial, the clips are already timed and set, but in smaller companies you are expected to input and be more flexible you may even chose back plates.*

How editorial impacts on your work decisions, length of plates.

Using photographic elements, 'temping' things up in absence of final elements.

# MODULE 001

The temp, the final and how you might be involved in working on either.

Accommodating and preparing for unexpected changes and understanding why they happen.

From editorial the images can be pre-graded in order to standardise the colour match across a range of shots. Thus, a knowledge of colour space is important as well as a basic knowledge of grading terms.

Colour space; what you see isn't what you get, (something that others in production don't always understand!).

Other people in the film process will want to see the look and stylistic veneer of the film, but the VFX artist needs the neutral plate that they can later push and modify. So there's a translation needed. Conceptually the look should be thought of as separate to the image, so the image is uncompromised and yet others can see the intention.

Colour space basics: video linear (rec 709), true linear, cineon PDlog685 and newer flavours of log colour space. This is how colour is captured or rendered. LUTs (look up tables) are ways of translating imagery to be visually useful or to transform an image from one colour space to another.

All VFX operations are achieved through linear colour space, since linear leads to predictable colour transforms.

Editorial sometimes supplies a Neutral Grade, (also referred to as a Tech Grade) that is termed a Linear Mult. This can be based around skin tone.

The new entrant needs an understanding of how to implement that grade, depending on the VFX company, either in Log or Lin. If it's Log it's an ADD or OFFSET, if Lin MULT or GAIN.

How an exposure node works and how and why it is applied. The processes by which Log becomes Linear.

This paradigm is also present in the notion of the colour decision list. The look that the DoP saw and chose on set travels with the material but isn't baked in. The colour decision List is the DoP's choice and how it travels as metadata through the pipeline needs to be appreciated.

Students should experience different formats in this module and learn when they might encounter them within the VFX process. Shooting formats are different from posting formats.

Is the image cropped in camera or in post? Understanding hard masking (in camera) 4 perf, 3 perf, 2 perf, open gate, super 35mm versus cinemascope, Vistavision, IMAX, Academy aspect ratios versus 185, 166, 178, 133, 235.

Soft masking (in post) and open gate.

Scanning and resolution: 2k, 4k and the use of proxies in compositing.

Bit depth: 8, 10, 16 bit and float/half float.

Major file formats: .dpx, .cin, .tga, .tif, .jpg, .exr.

Whereas large companies might have conversion built within their pipelines, smaller companies may employ a more hands-on approach where you are responsible for reformatting, for instance down-rezing film to fit video.

## OPTIONAL ADDENDUM: Stereo 3D

It needs to be noted that most VFX aspects of Stereo 3D are explored in other modules, since it has no unique bearing within this module. However, explanations that deal with the following may be judged useful:

- The impact of S3D on principal photography.
- Stereo 3D acquisition - split beam operation, convergence, parallax.
- Precision on set. For many mistakes, there's no fix in post.
- Post dimensionalising. 2D conversion should be seen as qualitatively different, not inferior.
- Pos/Neg screen space (world space, personal space).

## 7. KEY TEXTS/LITERATURE

Alton, J.(1995) *Painting with Light*, University of California Press

Mascelli, J. V. (1998) *The Five C's of Cinematography: Motion Picture Filming Techniques*, Silman-James Press, U.S

Okun J A., Zwerman, S. (Eds). (2010) *The VES Handbook of Visual Effects*, Focal Press

CVMP 2010 - 7th European Conference on Visual Media Production, CVMP 2010

[www.vfxnation.com/showthread.php/220-Camera-Specs-and-Resources](http://www.vfxnation.com/showthread.php/220-Camera-Specs-and-Resources)

[www.hollywoodcamerawork.us/vfx\\_index.html](http://www.hollywoodcamerawork.us/vfx_index.html)

## 8. SUGGESTED LEARNING ACTIVITIES

We recommend that students be exposed to a real film shoot. This might be at a neighbouring studio, department or even university. Obviously some kind of interaction with such a shoot would be useful, although not compulsory. Observing and understanding the roles of those participating are the main purpose.

Attending a mo-cap session would also bring to life the curriculum, although it is not necessary for a student to work on a mo-cap session if this is beyond the resource of the course. However students need to work with a variety of files and exercises that highlight and maybe problematise issues brought up in the curriculum.

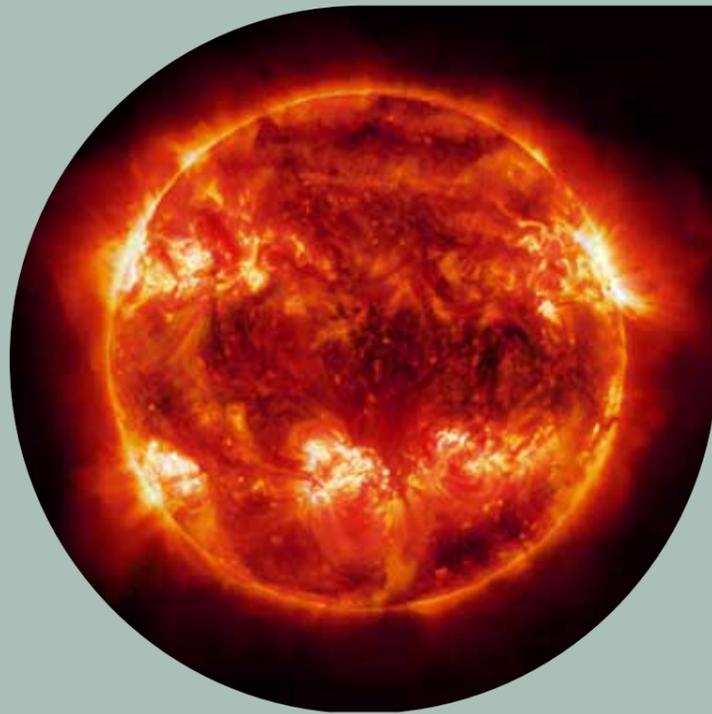
Student project idea: how would you gather useful measurements from a set without the help of technology? Smaller VFX outfits don't have access to LIDAR and technology (and neither do universities) so how would you collect this information from a film set yourself?



Courtesy: National Film and Television School, A Skillset Film & Media Academy

# CGI FOUNDATION (STILL IMAGE) FOR VFX

This module introduces students to the main principles of hard surface modelling in 3D space and the preparatory placing of those objects into a static composite. It deals with the challenge of creating 3D objects that will need to integrate with a background that will be from another source (typically a digital film camera), and making the 3D object conform or fit into that environment.



## MODULE 002: CGI FOUNDATION (STILL IMAGE) FOR VFX

### 1. MODULE DESCRIPTION

**This module introduces students to the main principles of hard surface modelling in 3D space and the preparatory placing of those objects into a static composite. It deals with the challenge of creating 3D objects that will need to integrate with a background that will be from another source (typically a digital film camera) and making the 3D object conform or fit into that environment.**

In order to keep focused on this integration this module does not deal with animation or rigging, which come in later modules.

This module is not just about modelling but also introduces the important notion of the virtual camera, and how the 3D software camera needs to match and replicate the qualities of the physical or real film camera.

The student will learn to analyse and to efficiently build forms using professional techniques, creating 3D assets in shot that may or may not be interacted with by real filmed actors.

*There will be an emphasis throughout this module on the importance of the minimum use of data needed to achieve the required quality when producing assets. This efficiency aspect also needs to be communicated to students concerning the influence topology has on texturing and rendering further down the pipeline.*

### 2. SUGGESTED PRE-REQUISITES

- A knowledge of 3D software modelling tools, preferably Maya or XSI.
- An awareness of Photogrammetry, the use of Cards, and image projection techniques (for instance our Matte Painting and Environments module)

### 3. SUGGESTED CO-REQUISITES

- Camera tracking
- 003: Foundation in VFX Compositing

### 4. AIMS

**This module aims to:**

- Enable students to build models with the most efficient use of data needed to achieve the required quality.
- Enable students to appreciate the influence topology has on subsequent texturing and rendering further down the pipeline.
- Give students professional practice in industry standard 3D software.

- Create the conditions that allow students to gain a working understanding of form and volume.
- Give the student a technical appreciation of the art of polygonal modelling, NURBS and subdivision surface modelling techniques, the pros and cons of each and an understanding of which technique is best suited to the task at hand.
- Present methodologies regarding analysis of the form and efficient dissection, breaking everyday objects into individual shapes.
- Give context concerning when texturing can usefully replace time consuming modelling operations, and how imitating lighting or reflections can sometimes be more efficient than processor-intensive operations.

### 5. LEARNING OUTCOMES

**On completion the student will be able to demonstrate:**

- The ability to place 3D models of their own creation into static composites, conforming to background image cues.
- A proficiency with hard surface modelling in 3D at a level that allows for further independent learning.
- The ability to develop a range of different models placed in different and challenging environments.
- Informed use of texturing, shading and other techniques geared towards integration within a digital film shot.

### 6. OUTLINE CONTENT

Students will learn how to model basic assets to fit and composite into a locked off back plate. However before modelling objects, the curriculum suggests examining how footage can be measured and interpreted so that the virtual camera within the 3D software camera can match the real camera used to originally shoot the footage.

#### Matching a backplate

Importance of camera film back, format, clipping planes, resolution, aspect ratio, focal length, camera height/angle/inclination, lens distortion.

*The important thing for matchmove in regards to the film back is its physical size in cm, mm or inches. A typical camera used for 35mm film is 0.968 inches wide by 0.735 high. This value is different depending on the camera. As an example consumer HD camcorders can have a sensor that is much smaller. Getting this value correct is important as it has an effect on the focal length when solving a camera match move. You can usually find the size of the film back (camera sensor) in the manual or specification documents online.*

# MODULE 002

How to measure the set and apply this within the 3D environment.

*The student needs to understand that the lens, focal length, camera film back and other positional data are critical as starting points for accurate matching of models.*

*Everything springs from that starting point.*

Discussion of lighting characteristics of the back plate/ photograph, outlining key or direct light (such as the sun) and ambient bounce or fill light (such as the sky). Shadow characteristics, highlights and materials (such as how wood looks, compared to metal, plastics etc).

## Modelling

How to model the everyday (ie real not fantasy) hard surface objects, using cross section line drawing or photograph.

Using references - photographs or line drawings scanned into 3D software, then modelled.

Use of established modelling techniques within 3D software, including but not limited to; an understanding of quad modelling with efficient edge loops, cartesian co-ordinates, NURBs versus Polys etc, primitives, topology, extruding, mirroring, lofting, translate, rotate and an understanding of UV mapping.

Assessing the best technique for the task in hand, whilst ensuring level of detail needed.

Turntabling 3D models.

## Basic texturing

Understand how CGI creates the look of real world objects by combinations of texture mapping techniques, shaders (how the surface and the surface beneath reacts to light) lighting and how LUTs are used (this will lead usefully on to CGI multipass compositing).

Photographing/sourcing textures: what makes a good texture? Remember, no reflections or shadows! Introduce the idea that you can paint them off.

Cleaning up or editing texture via paint techniques (e.g. Photoshop/BodyPaint/Mari), pointing out pitfalls of Google sourcing. Painting out highlights.

UV (or Ptex) mapping; laying out UVs/pelting compared to projection techniques.

*Lighting & texturing cheats may be outlined, such as when/how to fake reflections rather than using expensive raytracing techniques and when/how to bake elements such as shadows, highlights and ambient occlusion to be reused later, or even when/how to paint them into texture files.*

Texture projection method – the method used to project or stamp a photo (or other image) onto a model in 3D. This is a good starting point for a texture which the student can then clean up or fix.

Once the projected texture looks good then the student can bake out the texture, making sure the UVs of the polygons are correct.

## The asset pipeline

Explaining that UV layout techniques should be a common language between modelling and texturing and the influence that modelling techniques should have on texturing (avoiding stretching).

Strategic placement of seams in UVs to reduce any visible seams in the texture.

Techniques in dealing with texture seams and making invisible.

Deciding on where to concentrate to create the look. This will be a useful lead-in to the concept of look development later.

How diffuse, colour, bump, displacement, luminance or transparency maps can be used with shaders (using only software presets and no shader development).

Shader designation - understanding that shader and material, can be used interchangeably.

Specularity maps, material designation and basic (key/fill) type lighting.

Working with multipass rendered layers and grading in compositing.

Extracting all maps from a colour map and understanding where its specular points are etc. *Good Photoshop skills are needed here.*

Students need to be given practical experience of how to generate relevant passes, at least – colour, diffuse, shadow, specular and beauty.

Patching with photo images where appropriate rather than painting.

When to use procedural textures.

Awareness of multi-tiling for UVs.

Resolution issues and the usage of proxies for large textures.

## Rendering and compositing

Rendering beauty RGBA: Render Gamma settings, premultiplication.

Rebuilding the beauty from colour, specular and shadow passes.

The over, mult and add layer functions.

Matching focus, grain and grade (emphasis on techniques for matching black points).

Using ID passes to further control selective grading.

*Note: We recommend the teaching of basic look development is increased incrementally as the module continues rather than in a block. Students need to understand the relevant number of passes needed to achieve believability within the context of the shot. They should create the look development on one shot to explore how the workflow of texturing > lighting > shading > compositing can be tweaked (focusing more time and*

*resources at one stage than the others) so the process (or pipeline), can be applied to several shots efficiently.*

## Post camera effects

How to add effects in post. This should be divided into two sections:

- Matching the look of a real camera, depth of field, lens distortion, chromatic aberration, lens flare and bloom.
- Simple transforms, stabilisation, pans and tilts.

## 7. KEY TEXTS/LITERATURE

Brinkmann, R. (2008) *The Art and Science of Digital Compositing: Techniques for Visual Effects, Animation and Motion Graphics*, Morgan Kaufmann

Birn, J. (2006) *Digital Lighting and Rendering*, New Riders

Zwerman S., Okun J. A. (2010) *The VES Handbook of Visual Effects*, Focal Press

[www.cgtextures.com](http://www.cgtextures.com)

<http://lesterbanks.com/2010/11/maya-texture-projection-mapping-tutorial>

[www.youtube.com/watch?v=vTh0wSjF71U](http://www.youtube.com/watch?v=vTh0wSjF71U)

## 8. SUGGESTED LEARNING ACTIVITIES

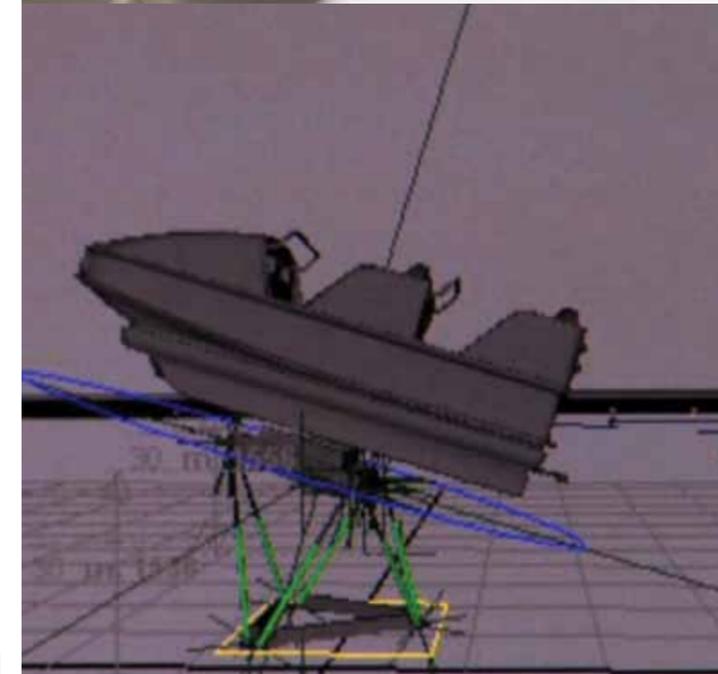
- Critical analysis, asking students to reconstruct efficiently an everyday object that they may take for granted (a postbox, street furniture). Ensure students critically compare their CGI version against the real thing via split screen.
- Picking a real object in the back plate and building it in CGI.
- Placing a built model into a well known film shot (borrowed from a BluRay DVD for instance)

### • Bake out a projected texture

*There are variants to this procedure, but this is the basic method.*

- Make sure the UVs of the polygons are correct. Look for a tutorial on unwrapping polygons. This isn't a problem if you are using NURBs.
- Find the texture that is being projected, and in the hypershade, select its SHADING GROUP NODE, (find the material and choose SHOW UP AND DOWNSTREAM CONNECTIONS).
- Select the polygonal object it is being projected onto.
- Then, in the hypershade go to the EDIT pulldown menu and select CONVERT TO FILE TEXTURE.
- You should now see a new material node in the hypershade, showing your new file texture.

- We recommend a dailies process throughout this module, with students sharing work progress, and engaging in presentation and peer critique.



# MODULE 003: FOUNDATION IN VFX COMPOSITING

## 1. MODULE DESCRIPTION

**Compositing is where a variety of disparate elements are brought together into a visually cohesive whole.**

As such the composite is the destination of a range of assets and great precision is needed to enable the viewer to suspend disbelief. Even when the result is not intended to be photoreal, it is vital that the final image is cohesive and seamless so evidence of its construction does not detract from story or meaning.

Whilst composited images do not need to be photoreal, this module focuses on the student's ability to combine elements into a seamless photographic image.

As such this module introduces students to 2D image basics, including layering, masking, simple keying, notions of colour space and 2.5D space and complements this with tuition on perceptual skills and the underpinning apparatus that can fool the eye and brain.

It is important to have an appreciation of the history of compositing and its roots in early photographic spectacles, a chronological thread which informs today's practice.

The students progress through the module accumulating techniques, being introduced to the efficient design of project set-ups and flexible reusable templates, building flow graphs to anticipate changes as they might be guided by a compositing supervisor or sequence lead, and developing the knack of actively second guessing what might later need changing. Students will learn that since shots can move from artist to artist they need to be built to be readable to others and be logically laid out.

*Note: Introducing the notion of the template or hero script here at the compositing foundation stage is valuable. Students could wire in similar input images to their attempted scripts and be challenged to talk through what is happening at each operation.*

*Although we aren't recommending students conform to a particular orthodoxy or standardised approach, students need to understand and evaluate in a systematic way the nodal process that creates their composite.*

## 2. SUGGESTED PRE-REQUISITES

- Basic photographic skills
- Computer literacy
- Basic Photoshop skills

## 3. SUGGESTED CO-REQUISITES

- Photography

## 4. AIMS

**This module aims to:**

- Instill in students a practical understanding of the building blocks of 2D VFX.
- Give students a grounding in 2D pixel math operations, allowing under the bonnet manipulation of images.
- Encourage students to dissect what makes a shot look right and visually coherent.
- Explain different approaches to manipulating colour and light.
- Explain different approaches to creating masks and isolating groups of pixels.
- Teach students about optimum processes and the importance of efficient ordering of image elements.

## 5. LEARNING OUTCOMES

**On completion students will be able to demonstrate:**

- Proficient use of layering and combination of disparately created elements into a perceptually cohesive whole.
- The creation of seemingly photoreal or seamless images using a variety of methods.
- Elements made to match a background, using common compositing techniques such as edge quality, focus, colour, grain/noise structure etc.
- They have explored both 2D and 2.5D methodologies and created composites for both, understanding differences between the two approaches.
- They can combine different CGI passes appropriately (at least diffuse, colour, specular and shadow should be covered).

## 6. OUTLINE CONTENT

Divided into sections

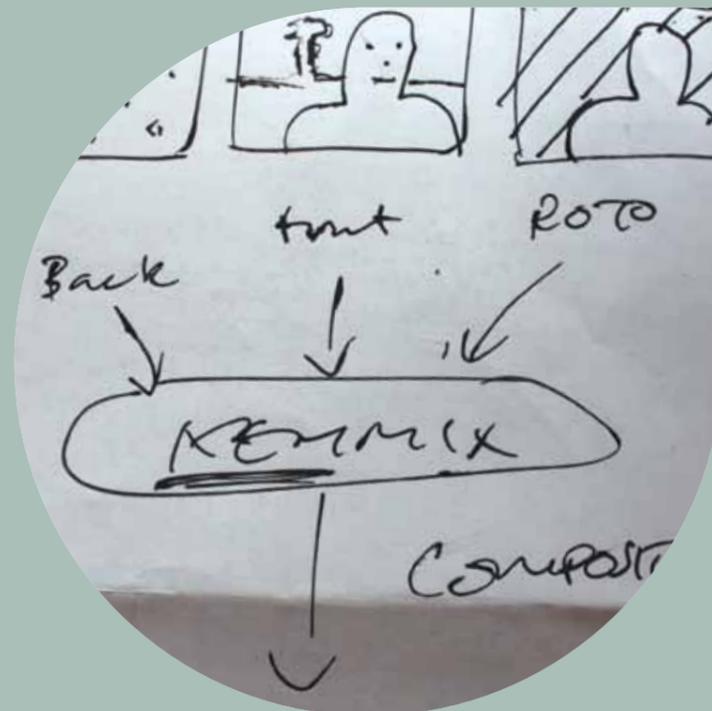
### History of compositing

Rewinding in camera, matte, stop motion, optical printing.  
Why things are done in a certain way. Roots of some of the terminology.

Simple pixel math operations (at least: Over, Multiply, Add, Subtract, and Screen).

A demonstration of a composite built entirely with maths (Expression in Nuke, ColourX in Shake) nodes. How a key can be pulled with an expression, or how an over node is built through maths, for instance.

Courtesy: Ian Murphy



# FOUNDATION IN VFX COMPOSITING

Compositing is where a variety of disparate elements are brought together into a visually cohesive whole.

# MODULE 003

## The colour pipeline: from acquisition to delivery

Using pre-grading plates via offset or gain rgb changed values. The colour decision list. Checking VFX comp grading over a wide gamut - pushing the comp application's viewer via exposure or gamma controls and/or checking the comp in log as well as linear with viewer lut applied.

## Colour space and the use of LUTs

Input, compositing in linear light space, implications in DI and for cinema delivery. Gamma, srgb, CIE 1931 standard observer, cineon PDlog 685, other log implementations, dpx and exr formats, rendering the output.

## Premultiplication

The concept of r,g,b,a as separate channels, how the pixel math operations affects channels and eventually the image; premultiplication artifacts, un-premultiplying and its uses.

## Project organisation

Order of node grouping in the script should reflect the order of layers in the comp. Use labels, colour and thumbnails to organise your script. Building flow graphs to anticipate changes with the logical grouping of operators; for instance clustering colour corrections transforms etc, together (avoiding concatenation) for filtering. Ensuring flow graph readability, so a shot can move from artist to artist.

## Establishing depth cues

Colour, tone, depth of field, scale and position, layering (putting part of the background, back on top of the CGI) relative motion and fog. These may also be discussed in relation to 2D to stereo 3D work.

## Building up layers from simple sources

Creating cutouts via masking, comparing Bezier with natural splines; editing masks, feathering and edge blur. Work with a minimum of three layers.

## Luminance keying

Garbage masking/keying, core masking/keying, union and inside operations, grain reduction techniques, tonal and/or colour correction, using a single rgb channel to key from.

## Post processing the matte

Filtering, erode/blur/edge detect, averaging single frame mattes together, tracking single frame mattes on to moving edges, painting onto mattes and use of stroke interpolation for fine detail.

## The lens, colour and the camera

Matching edge quality, focus, tone/colour and image texture (grain).

## Understanding the concept of multipass CGI compositing

Using the correct compositing math to build, combinations of (at least) colour, diffuse, specular, and shadow passes together to form the beauty pass. Which pass should you change and when?

## Layering in 2.5D space

2.5D basics and system set-up. Cards, displacement, distortion, arrangement in space, camera animation to give false parallax, combination of 2.5D system with 2D layering.

## Warping tools

Compare grid and spline warping operations with 2.5D card distortion operations, (for example to adjust horizon lines and correct exaggerated perspective).

## Intro to stereo compositing

Dimensionalising the shot using masking, cards and card displacement.

## Finishing

The final touches such as dust hits on footfalls, warping clothing on interaction, particulates in the air, manipulating the all-too-perfect CG into a photographic image.

## 7. KEY TEXTS/LITERATURE

Brinkmann, R. (2008) *The Art and Science of Digital Compositing: Techniques for Visual Effects, Animation and Motion Graphics*, Morgan Kaufmann Series in Computer Graphics

Wright, S. (2010) *Digital Compositing for Film and Video*, Focal Press

Lanier, L. (2009) *Professional Digital Compositing: Essential Tools and Techniques*, John Wiley & Sons

Drate, S. Salavetz, J. (2009) *VFX Artistry: A Visual Tour of How the Studios Create Their Magic*, Focal Press

James, J (2009) *Fix It In Post: Solutions for Postproduction Problems*, Focal Press

Sawicki, M. (2007) *Filming the Fantastic: A Guide to Visual Effects*, Focal Press

Zwerman, Okun (2010) *The VES Handbook of Visual Effects*, Focal Press

Ganbar, R (2011) *Nuke 101: Professional Compositing and Visual Effects*, Peachpit Press

## 8. SUGGESTED LEARNING ACTIVITIES

- Exercises can be based on re-visiting the integration of assets from 002: CGI Foundation (still image) for VFX such as a sky replacement or multipass photographic exposure. For instance one pass could feature an area of blown out exposure (e.g. a window in a room) and one pass being exposed for the interior. Both passes can be integrated into one rendered comp which could then progress from being a locked off shot to a moving camera shot.
- Simple photographed elements on green screen (or created In CGI) could be used to teach grading. The ability to tie elements together through match grading so tone, colour, edges and direction of light are all matched.

- A teaching pack of back plates could be prepared. For example a field containing reference objects such as a fence or farm building or vehicles is shot at different times (could be time lapse photography) as the sun comes up and changes through time.
- Students to observe and describe through colour temperature changes how diffuse or direct the light is, what angle the direct (sun) light is at, shadow quality, haze etc, in the image.
- Additional foreground elements such as another fence, the farmer or some flowers/crops could then be photographed against green screen and supplied pre-multiplied or created as CGI. There are then options in matching these elements through studio lighting techniques. Another option if available is to texture and light – backlight/front light/side light the CGI models to try to replicate the sun's effects as on the background. Students then have to match elements in purely by comp techniques such as match grading, edge grading, edge blending.
- Make students unexpectedly swap complex comps halfway through a brief, to ensure they learn the need to lay out work rationally, thinking about how best others might interpret and utilise. Getting accustomed to dailies, revisions and working efficiently. Building node networks/flow graphs/scripts that are tidy and easy for others to understand. The concept of building tweak/change controls into a script, should be clearly understood and demonstrated. These ideas should be introduced slowly but reinforced throughout all compositing modules.
- One possible future trend students might want to research and compare with existing techniques within compositing for VFX is that of 'deep image compositing'.

# MODULE 004: THE MATTE

Courtesy: National Film and Television School, A Skillset Film & Media Academy



## THE MATTE

This module examines different methods by which mattes can be created and how they might be manipulated and used in VFX compositing.

### 1. MODULE DESCRIPTION

**This module examines different methods by which mattes can be created and how they might be manipulated and used in VFX compositing.**

The integrity of the matte is vital in VFX and it must be rigorously examined and tested throughout its creation and implementation. Precision is called for and there are a number of tools and methods by which a matte can be extracted from an image. The student needs to appreciate the most appropriate and efficient way to create a matte under the circumstances.

This module examines roto-scoping (mattes created by hand), keying (mattes made by colour or pixel range) and several variants such as mattes created by math operations.

It instils best practice by referring to the matte independent of the image and being attentive to issues regarding edge and core. Students are exposed to different tools and gain a practical understanding of their relative strengths and weaknesses.

### 2. SUGGESTED PRE-REQUISITES

- Optional: **006: 3D Matchmoving for VFX**

### 3. SUGGESTED CO-REQUISITES

- Optional: **005: VFX Paint and Rig Removal**
- Optional: **012: CGI Lighting and Look Development for VFX**

### 4. AIMS

**This module aims to:**

- Enable students to make informed choices about which method of matte creation is the most appropriate.
- Impart the main working practices of roto-scoping and its context for matte extraction.
- Present a range of keying strategies and processes.
- Assist the student in the development of observational and analytical skills which lead to the successful recreation of edge artifacts in order to make seamless images out of multiple elements.

### 5. LEARNING OUTCOMES

**On completion students will be able to demonstrate:**

- Effective and efficient use of roto-scoping practice to new entrant level.
- Effective and efficient use of keying processes displayed through a series of professional level images.
- The ability to make decisions regarding the best utilisation

of matte extraction techniques, including combinations of keying and roto processes where necessary.

- Analytical and observation skills at work in the quality and integrity of edges and core body of the image that is supported by the matte.

### 6. OUTLINE CONTENT

#### **Rotoscoping as hand matting for VFX work**

A demonstration of how your mattes are used in a composite.

Analysing and planning your shot, estimating time and resources.

The pipeline: planning your own roto or taking a brief, initiating and completing.

Recognising which elements should be roto-scoped, where mattes are better extracted with other methods and how such mattes might be combined.

Breaking the shot down into shapes; natural splines for organic shapes, beziers for regular shapes.

Finding the frame with the most detail and working backwards.

Edges: finding the hard edge and drawing a spline to it.

Making motion blur within the matte and accurately matching the fall off on edges of rapidly moving elements within the plate.

Edge quality: hard or soft edged matte? Ask the compositor!

Animation: thinking like an animator, looking for natural keyframes – making the computer do the work.

Why consistency over time is more important than following every nook and cranny.

Using rotate and scale on an entire shape or on groups of points.

Dealing with organic articulated forms: one point and two point stabilisation of the plate and the use of the same data to de-stabilise the roto shapes before rendering them as mattes.

Boolean operations – Union, Plus, Inside, Minus, Outside, XOR.

Inorganic or static forms: point and area/planar/corner-pin tracking approaches to the roto-scoping of static geometry.

Understanding how to use appropriately positioned cards and 3D camera tracking to project roto shapes onto edges of static objects within the software's 2.5D system. This saves a lot of effort keyframing various splines to fit, as the virtual camera used to view the scene has already been

# MODULE 004

tracked. As an example the technique can be used to make a matte for the skyline above a building, where the sky is eventually to be replaced.

Rendering different roto-mattes to separate channels.

Rendering and naming e.g. renaming parts of body to distinguish different actors.

Making garbage mattes and assisting the compositor with matting solutions as required.

## Blue/green screen keying as procedural matting for VFX work

- Types of key, their differences and properties;
- Chroma.
- Colour separation and channel keying.
- Luma.
- Difference matting.
- Motion keying.
- Image based keying.
- Proprietary keyers; Ultimatte, Keylight, Primatte.

Techniques for pre-processing the plate.

The process of screen evening or levelling.

Creating a spill map, and de-spilling techniques.

De-graining techniques.

Creating your own clean greenscreen plate.

Matte density. Using over and under-exposure (in the viewer) to test matte density.

Common matte combining operators (add, mult, subtract, etc).

Methodologies:

- Pulling mattes with inside, outside, and edge keyers.
- Edge matte/body matte approach.
- Split keying; different keys for different portions of the plate.

How colour dilation can affect the matte (sometimes referred to as edge extrusion).

The maths of keying. Building your own keyer.

Tracking in still mattes to avoid boiling on very fine detail, if all else fails.

Working with soft focus, semi-transparency and motion blur issues.

Using painting techniques for restoring very soft/motion blurred edges.

The challenges of integrating edges to look natural.

How to approach colour bleed and other problems.

Post-processing the matte.

Match grading tools and techniques in order to get coherent elements - offset, gain, gamma, lift, cross-talk, black point, white point, curve tools and exposure tools.

Log versus Lin grading

*Tutors note: All channels use greyscale to represent tone in exactly the same way, so mattes can be stored in any channel (r,g, and b as well as a).*

*Complete transparency in the matte is at value 0 and complete opacity is at value 1, so values inbetween represent a level of semi transparency. Matte values should always be clamped at 0 and 1, otherwise the premultiplication (matting) math with the foreground colour image may be incorrect.*

## General project organisation

Order of node grouping in the script should reflect the order of layers in the comp. Using labels, colour and thumbnails to organise your script.

## 7. KEY TEXTS/LITERATURE

[www.effectscorner.com](http://www.effectscorner.com) Scott Squires video tutorials on rotoscoping technique

[www.digitalcinemasociety.org/Popup.php?video=GreenScreenSteveWright.mov](http://www.digitalcinemasociety.org/Popup.php?video=GreenScreenSteveWright.mov)

[www.hollywoodcamerawork.us/greenscreenplates.html](http://www.hollywoodcamerawork.us/greenscreenplates.html)

Wright, S. (3rd edition 2010) *Digital Compositing for Film and Video*, Focal Press;

Brinkmann, R.(2008) *The Art and Science of Digital Compositing*, Morgan Kaufmann

Okun, J.A (Editor), Zwerman, S. (Editor) (2010) *The VES Handbook of Visual Effects: Industry Standard VFX Practices and Procedures*, Focal Press

Foster, J. (2010) *The Green Screen Handbook: Real-World Production Techniques*, Sybex

Bratt, B. (2011) *Rotoscoping: Techniques and Tools for the Aspiring Artist*, Focal Press

## 8. SUGGESTED LEARNING ACTIVITIES

- Developing a critical eye for edge quality through looking at existing video and film material. Scene photography of actors from existing productions (with as little compression as possible) will provide better examples than blue/green screen sources. How does motion blur, fine hair, organic versus geometric form, camera focus and the lighting in the environment effect the edges in the image? Are edges the right level and gradient of translucency? How are they described in terms of matte density and greyscale level in the matte (alpha channel)

across specific areas? (The range of 0 to 1 should be used where possible, as opposed to 0 to 255).

- Some of these clips could then be rotoscoped. An affinity for edge quality will then be further enhanced through students literally having to recreate the look of the original by adding feathering, edge blurring and motion blur.
- A and B comparisons should be viewed on the biggest screen available, with the original clip viewed against the premultiplied (matted) clip on mid grey. This gives a good comparison. A critique of technique should take place summarily. Do edges boil, jump or chatter? Is there too much original background texture/colour visible or too little foreground object texture/colour? In other words are the roto'd edges too loose or too tight? Can problems be fixed quickly or will shapes need to be re-animated?
- Students need to get used to the high level of quality control needed where roto mattes are made and how (although the process is relatively manual as opposed to more automatic keying processes), the end product is the same – a coherent matte.
- Simple photographed elements on greenscreen could be used to teach integration (pulling the key/de-spilling and match grading). Students need to gain the ability to tie elements together through match grading so that tone, colour, edges and direction of light are all matched and an integrated image fools the eye.
- A teaching pack of back plates could be prepared, for example a field containing reference objects such as a fence, farm building or vehicles could be shot at different times (maybe time lapse?) as the sun moves position.
- Students can then analyse colour temperature changes and describe how diffuse or direct the light is, what angle the direct (sun) light is at, shadow quality, haze etc, within the image.
- Additional foreground elements such as another fence, farm machinery, hay bales etc, could then be photographed against green screen. Students could then explore different strategies towards pulling a key with appropriate edge detail and softness, matching these elements through studio lighting techniques or purely by compositing techniques such as match grading, edge grading, edge blending.

# MODULE 005: VFX PAINT AND RIG REMOVAL

## 1. MODULE DESCRIPTION

**Wires, harnesses, markers and all kinds of film apparatus may need to be digitally removed from a shot. Having played a purpose in assisting the shot, they now need to be rendered invisible to the eye. In addition there are sometimes mistakes on the shoot, such as boom mics or crew members accidentally appearing in the frame and other incongruous elements that may disrupt the story, such as pylons or wristwatches in a period drama.**

The same digital tools may also be used for image restoration - removing dust, replacing and substituting dropped frames or cleaning up stereo 3D image pairs. Traditionally all these tasks belong to a digital preparation artist or paint artist and expertise in rotoscoping is considered the entry point into a compositing career. You can progress into paint/prep, starting at dustbusting, marker removal scratch repair and rig removal, and all these techniques are introduced in this module.

Today, the term paint artist is a catch-all term. It is certainly not all about the act of digital painting although such skill with a Wacom pen is held in high regard. People who can paint their way out of trouble in the absence of photography are highly prized.

In dealing with large resolution images, high-level quality control and a dispassionate and discerning eye for repair work is necessary. Such work needs to be invisible and unnoticed and students will need to prove it to themselves and others with the use of A/B comparisons.

In this module the student will learn traditional prep techniques such as paint, patching, de-graining, tracking and retiming as well as contemporary 2.5D and image re-projection techniques.

## 2. SUGGESTED PRE-REQUISITES

- None

## 3. SUGGESTED CO-REQUISITES

- 002: CGI Foundation (still image) for VFX
- 004: The Matte
- 006: 3D Matchmoving for VFX

## 4. AIMS

**This module aims to:**

- Enable students to experience a range of rig removal/ image restoration problems and develop appropriate strategies for solving them.
- Inculcate in students the importance of quality control and invisibility of repair.

- Promote the methodology of the minimum amount of change to the source material to get the job done.
- Give students experience of both 2D and 2.5D modes of working and a good sense of when either is best deployed, or even combined.
- Impart key art and technology skills in the areas of rig and tracker marker removal, dustbusting, de-graining and re-graining, patch fitting, painting, 2.5D, image restoration and repair and stereo 3D repair.

## 5. LEARNING OUTCOMES

**On completion students will be able to demonstrate:**

- Robust entry level skills in paint, restoration and rig removal for VFX.
- A portfolio of practical solutions and repairs to images and shots using a mix of rig and tracker marker removal, dustbusting, de-graining and re-graining, patch fitting, painting, 2.5D, image restoration and repair, exhibited through A/B comparisons where appropriate.
- Painting skills through proficiency with a pen and tablet.
- An awareness of when to use 2.5D techniques in situations that merit it supported by examples.
- Sound judgement on which technique to use to get a satisfactory high quality result using the least amount of time and resources.

## 6. OUTLINE CONTENT

Here is a list of the main points this module should cover, divided into sections.

**The theory of rig removal, including image processing, vector maths and tracking data.**

A clear understanding of the underlying principles of how optical flow and motion estimation tools and technologies work.

.....  
What is spatial motion estimation both local and global?  
.....

What is temporal motion estimation?  
.....

How are forward/backward motion vectors produced and how are they used?  
.....

How masks can be used to help the optical flow analysis.  
.....

Understanding the difference between area/planar/corner pin tracking and point tracking. Analysing the image for position (transformation) or scale and/or rotation (translation) changes. Search and target regions, fixed and roaming target updates. What makes good tracking regions (planar/area/corner pin tracking) or features (point tracking)? 2D versus 3D tracking, when you should track in 2D or 3D. How to convert 3D tracking to 2D cornerpins or 2D track points.  
.....

Courtesy: National Film and Television School,  
A Skillset Film & Media Academy



# VFX PAINT AND RIG REMOVAL

Wires, harnesses, markers and all kinds of film apparatus may need to be digitally removed from a shot. Having played a purpose in assisting the shot, they now need to be rendered invisible to the eye. In addition there are sometimes mistakes on the shoot, such as boom mics or crew members accidentally appearing in the frame and other incongruous elements that may disrupt the story, such as pylons or wristwatches in a period drama.

# MODULE 005

How to examine tracking data animation curves, utilise jitter removal and how the tracking data may then be applied as match move or stabilisation data.

## The art of rig removal

The student will experience a range of rig removal/image restoration problems and develop appropriate strategies for dealing with them. Small areas of image that need to be repaired/restored can usually be dealt with by masking or painting in sections of a clean plate.

*Note: These may be provided by the tutor or accidental clean sections from other frames may be found in the clip, or the student may paint up a plate, by creating a collage of different frames together or by clone brushing. Large areas of image that need to be repaired or replaced may mean going down the route of complete image reconstruction, using either patching or 2.5D re-projection techniques.*

Developing art skills that make your fixes invisible! As an artist, the student needs to decide on the tipping point between not successfully removing an object and going too far so that your brush strokes or mask lines become visible (boiling). It might be that a patched section has grain structure that doesn't match the plate, or the image detail has been softened too much in the process of completing the fix.

*A good exercise in the quality control expected in rig removal for VFX is to A/B compare your finished repair or restoration (a greater challenge would be where a large part of the image has been restored – for example taking out a person in the foreground of a shot) against the original plate. How much image detail/grain has been lost? Would you consider your work to be the same plate with just the object/person removed or have you gone too far and the image betrays evidence of a clean-up?*

## Tracker Marker removal on blue or green screens

Students will be able to use dedicated tools for this task or use animated masks, filled with colour sampled from an area of blue or green backing. Animated or interpolated brush strokes of solid colour can also be used, but care needs to be taken to avoid paintstrokes boiling and checks made that all edges where markers may have originally passed under actors or objects, are correct.

*As with all tasks, Students should start with broad strokes and then refine until the result is seamless. The process should start with garbage masks filled with screen colour, through colour correction techniques to neutralise the markers that overlap the subject, and then down to frame by frame painting.*

## Dustbusting

Students need to be able to use dedicated tools, or alternately practice manually clone brushing frame by frame over the dust or dropout (sometimes still called neg hits) from a copy of the clip that has been typically offset one frame forward or one frame backward. Cloned brush strokes need to be just large enough to cover the neg hit.

*An explanation should be given regarding how technologies such as infrared scanning can assist, with advice on the pitfalls of automated techniques and how to minimise any errors.*

## Image de-graining

The student will examine images on a per channel basis, assess grain or noise structure and learn a range of techniques for de-graining still and moving images, including the use of blur filters, frame averaging and optical flow.

*The default isn't always optimum – it depends on the image. The student needs to understand and employ ways of controlling the blur so they have minimum grain but maximum image detail. Examples include using edge detection filters as protection masks and blurring separate image channels by different amounts.*

*The theory behind frame averaging (sometimes called compounding) will be expounded and how this may be used to produce a de-grained still, with reasonable image detail. The technique has a wider application in making single frame mattes of fine detail that can be tracked in, when all else fails.*

*The use of optical flow based tools to de-grain single frames or clips will be covered, as well as modern complex de-noising filters and FFT techniques.*

## Patch fitting

Understanding how to align and 2D matchmove a de-grained clean still to the appropriate part of the plate, as well as how to reposition over time (animate) or time offset/loop sections of plate.

Explore and note the characteristics of different blur filters as they apply to an image. After the clean still has been moved to fit the plate, differences in (for instance) cubic, rifman, or parzan can be understood from both the perspective of pixel math or from looking at the image for softness.

## Painting

As well as feather masking in sections of a fitted plate, it is very often desirable to develop skills with a graphic tablet pen, as sensitive frame painting is very often the only way to reveal back in small areas of the fitted patch, or to subtly paint into areas where there is plenty of movement.

Being able to paint with subtlety and accuracy is an essential skill for a Prep Artist. Students should pay attention to boiling and understand how brush size, type and opacity, together with dexterity and a steady hand, can improve paint work.

*Note: It is almost impossible to produce good paint work using a computer mouse. Skill with a graphic tablet pen is essential.*

## Re-graining

Understand how to use appropriate tools to match the grain structure on your patch to the original plate. This will usually mean working and checking the image carefully on an individual channel basis. Sometimes difference keying

the repaired image with the original is necessary in order to isolate an area to apply grain to.

## 2.5D

Using 2.5D techniques for repair work, the student will need to be able to use and understand how a 3D camera tracker works. They will then need to be able to use the 2.5D system in the software to re-project still or painted patches back onto some geometry or cards that have been arranged appropriately in front of the tracked, virtual camera. Understanding how images can be painted (and then UV textured again) onto models can also be useful.

*Through exercise students will experiment when 2.5D is an appropriate approach. If the image has already been camera tracked or has a fair amount of parallax in it, then 2.5D is a workable option, otherwise the traditional patch and paint techniques may be quicker. Playing the role of the prep artist the student must be able to intelligently choose which route to go down. Complex image rebuilds may require a combination of traditional and 2.5D rig-removal techniques.*

## Image restoration and repair

Students learn and develop techniques and routines for image restoration and repair (and how to win the heart of the post supervisor when something has happened to the rushes, or to circumvent the need for a very slow CGI re-render).

Students learn how dedicated tools, optical flow or channel maths may be used to repair scratches, tears, damaged film, digital dropout or dropped frames from CGI renders, missing colour channels, film scanning errors or rolling shutter artifacts.

## Stereo 3D specific issues

Students will be able to align stereo 3D image pairs vertically, and remove specular highlights, flares or other polarising artifacts from one of the stereo pairs. They will be taught how to fix image ghosting.

*Optional: Students can use 2.5D roto-mation techniques to complete 2D to 3D conversion work.*

## 7. KEY TEXTS/LITERATURE

Brinkmann, R. (2008) *The Art and Science of Digital Compositing: Techniques for Visual Effects, Animation and Motion Graphics*, Morgan Kaufmann

<http://conradolson.com/tag/rig-removal>

Eismann, K. Palmer, W. (2005) *Photoshop Restoration and Retouching*, New Riders

Ctein (2010) *Digital Restoration from Start to Finish: How to repair old and damaged photographs*, Focal Press

James, J. (2009) *Fix It In Post: Solutions for Postproduction Problems*, Focal Press

## 8. SUGGESTED LEARNING ACTIVITIES

### • The art of rig removal

Exercises should be presented where students repair/restore small areas of image by masking or painting in sections of a clean plate. *These may be provided by the tutor or clean sections from other frames may be found, or the student may paint up a plate. Large areas of image that need to be repaired or replaced may mean going down the route of complete image reconstruction, using either patching or 2.5D re-projection techniques.* The student should get used to A/B comparing their finished work against the original plate. How much image detail/grain has been lost?

### • Tracker Marker removal on blue and green screens

Students uses animated masks, filled with colour sampled from an area of blue or green backing. Animated or interpolated brush strokes of solid colour can also be used, but care needs to be taken to avoid paint strokes boiling and checks made that all your edges where markers may have originally passed under actors or objects, are correct.

### • Dustbusting

Students practice manually clone brushing frame by frame over the dust or dropout from a copy of the clip that has been typically offset one frame forward or backward.

### • Image de-graining

The student will examine images on a per channel basis and assess grain or noise structure, and utilise a range of techniques for de-graining still and moving images, including blur filters, frame averaging and optical flow. The student needs to employ ways of controlling blur by using edge detection filters as protection masks and blurring separate image channels by different amounts.

### • Painting

Skills with a graphic tablet pen need to be encouraged, as sensitive frame painting is very often the only way to achieve invisible and subtle results. Students should pay attention to boiling and understand how brush size, type and opacity (together with dexterity and a steady hand) can improve paint work.

### • 2.5D

This could involve the re-projection of painted patches back onto some geometry or cards that have been arranged appropriately in front of the tracked, virtual camera. Students will experiment when 2.5D is most appropriate. Playing the role of the prep artist the student must be able to intelligently choose which route to go down.

### • Image restoration and repair

*Students should use optical flow or channel maths to repair scratches, tears, damaged film, digital dropout or dropped frames from CGI renders, missing colour channels, film scanning errors or rolling shutter artifacts.*

### • Stereo 3D

Students align stereo 3D image pairs. They will be taught how to fix image ghosting.

# MODULE 006: 3D MATCHMOVING FOR VFX

## 1. MODULE DESCRIPTION

**This module concentrates on the process of achieving an accurate camera solve or matched object geometry from plates shot with moving film cameras.**

Emphasis is placed on how 3D matchmove has become the cornerstone of career progression within VFX (especially within 3D departments) and how accurate 3D matchmoving is crucial for the production of believable CGI.

There is an emphasis on the importance of the minimum use of data needed to achieve required quality and in particular the influence that generated topology has on texturing and rendering further down the pipeline.

*Whilst camera tracking and object tracking are taught within this module, body tracking (roto-motion) is part of 010: CGI Animation Foundation for VFX module.*

## 2. SUGGESTED PRE-REQUISITES

- Imperative: **001: Acquisition for VFX**

*Students need to understand how tracking markers and on set measurements, lens data, witness camera images, LIDAR scanned geometry might be used).*

## 3. SUGGESTED CO-REQUISITES

- **002: CGI Foundation (still image) for VFX**
- **003: Foundation in VFX Compositing**

## 4. AIMS

**This module aims to:**

- Add the element of camera motion to the image, enabling the student to bring previous VFX competencies into a more realistic and professional context.
- Inculcate in the student the importance of creating efficient and minimum data for the project at hand, always mindful of the pipeline and deadline they are working within.
- Enable students to understand the difference between object tracking and camera tracking.
- Provide practical tuition of the requisite depth to gain the successful student entry into a 3D department.

## 5. LEARNING OUTCOMES

**On completion students will be able to demonstrate:**

- They can extract motion data professionally across a range of film plates.
- They have generated successful renders of test geometry that conform to motion within a shot.

- They value and can gauge the prerequisites needed for an efficient pipeline.
- They appreciate the inherent limitations within the properties of the data and imagery they have generated.

## 6. OUTLINE CONTENT

*Having an accurate scene in 3D of the on-set environment will assist a matchmover in making their camera as accurate as possible. In the film industry a digital representation of the on-set environment is desired wherever possible.*

### **The difference between object tracking and camera tracking.**

Observing and deconstructing examples in film and commercials

### **How tracked CGI cameras (often referred to as shot or render cameras) can be used at various stages of the VFX production pipeline.**

Attaching or 'sticking' assets to the perceived floor of the plate (as in the example of CGI motor vehicles).

Being aware that you are creating tracked CGI camera data that may be used by others such as environment artists, 2D prep artists, roto artists and compositors.

### **Image formats.**

Understanding how anamorphic video images need to be pre-rendered flat and how cropping the plate before camera-tracking it can present problems.

View examples of common image formats, with reference to their aspect ratio, resolution and crop.

### **Techniques for undistorting (de-lensing) the plate.**

Pin cushion and barrel distortion.

De-lensing via image analysis, drawing vectors or lens grid analysis.

Understanding the need to re-distort the plate after the CGI is composited.

How ST maps can be used in compositing.

### **Analysing camera movement.**

Initial analysis via close inspection of the plate photography. The differences between parallax, nodal (e.g. tripod based panning or tilting) as opposed to non nodal (dolly or handheld camera motion) and camera movement with mixed motion all need to be clearly understood. Students need a strong understanding of parallax and how it helps camera tracking software calculate an accurate track.

Courtesy: National Film and Television School, A Skillset Film & Media Academy



# 3D MATCHMOVING FOR VFX

**This module concentrates on the process of achieving an accurate camera solve or matched object geometry from plates shot with moving film cameras.**

# MODULE 006

It is important students understand the difference between a camera tracking in or out and zooming, how this looks (the effect on parallax etc.) and how it affects the software's ability to generate a successful track.

*Note: A discussion with a range of examples of images shot in different formats, with different lens distortion and camera movement (recorded material or commercially available DVD's can be used), needs to widen student experience of the video formats they are likely to experience directly. Emphasis should be placed on students developing skills in analysing the image, so decisions are informed when it comes to the use of 3D matchmoving software applications.*

## Camera tracking.

### a) Making use of on-set data

*001: Acquisition for VFX module needs to be studied as a pre-requisite, as it is necessary to understand how on-set data is now used in a 3D matchmoving application.*

- Importing media (the plate) and set-up of scene/project within 3D matchmoving software.
- Image format: flat or anamorphic. Pixel resolution.
- The camera film back (size in cm, mm or inches. For instance, a 35mm film camera is 0.968 inches wide by 0.735 high)
- The lens focal length.
- Use of other on-set notes such as camera height, angle and distance from set.
- Operation of 3D matchmoving application to produce an initial track and camera solve.
- Understanding the principles of LIDAR.
- Understanding how a total station survey works.

### b) Determine axis and ground plane

- Drawing vectors to determine axis planes (at least x,y) within the plate.
- Setting the ground plane.

### c) Attempt to improve the solve

- Use test objects and/or test geometry and caching to quality check the work.
- Draw masks and/or deleting bad tracks.
- Make use of user features or Golding.

*Golding refers to the user selecting what tracks he/she thinks are good (gold standard) tracks. If tracks are golded, the tracking software will take them into account to a greater degree than other tracks when doing the camera solve.*

- Join tracks.
- Contrast grading and/or de-noising the plate.
- Checking there are no jumps/kicks/slips in the camera's movement by looking at the matchmoved camera from another camera – does it move like the real camera? Check the animation graph and see if there are any frames which look wrong (spikes in the graph). The CG camera should not have an unrealistic movement which the real-world camera could not have done (for example move through a wall).
- Rendering the plate with test objects and/or geometry for approval in dailies.

*Note: if a shot is tracking in on an area of detail it can often be worth reversing the plate and tracking it backwards since the software will prefer for additional detail to enter the shot as it progresses, rather than having it gradually lose tracking points as the camera moves in.*

### d) Exporting

*Students need to understand how certain exported data from camera tracking is of use elsewhere in VFX. For example how point clouds are useful to modellers and how a tracked camera can be used by roto and clean-up artists.*

- Exporting the camera for use in other applications.
- Exporting the point cloud for use in modelling or other applications.
- Exporting individual tracks for use in compositing or other applications.

### e) Object tracking

Understand how to track a moving object within the plate, so that geometry may be applied at a later stage. Examples of this could be extending or remodelling cockpit controls in an aircraft (this would combine well with 002: CGI Foundation )still image) for VFX, 003: Foundation in VFX compositing and 005: VFX paint and rig removal.

Another example might involve moving vehicles (body work can be added to, or be re-modelled) This may require a camera track first, before working on an object track. If the camera is moving significantly then it would more likely need a camera track before a good object track can be achieved.

Object tracking items that flex, bend or warp can be very difficult. Tracking software as a whole is not so good at tracking things that deform, for example cloth. Usually you need to have a rig and controls in order to track deforming objects like a face or clothing.

## Body tracking (roto-mation), is included in 010: CGI Animation Foundation for VFX

*Note: The proof of an accurate camera track or object track is test geometry that remains firmly planted to the spot when overlayed onto the plate. 3D matchmove dailies allow for tracking work to be quality checked by a supervisor whilst looking at these overlayed renders. Students could be encouraged to take the 3D matchmove and complete modelling, texturing, lighting and compositing of a more fully fledged CGI asset into a plate shot with a moving camera.*

### Optional

An understanding of the principles of S3D tracking. There is no cheat!

## 7. KEY TEXTS/LITERATURE

Dobbert, T. (2005) *Matchmoving: The Invisible Art of Camera Tracking*, Sybex

Sawicki, M. (2007) *Filming the Fantastic: A Guide to Visual Effects*, Focal Press

Zwerman, Okun (2010) *The VES Handbook of Visual Effects*, Focal Press

[www.vfxnation.com/showthread.php/220-Camera-Specs-and-Resources](http://www.vfxnation.com/showthread.php/220-Camera-Specs-and-Resources)

[www.hollywoodcamerawork.us/trackingplates.html](http://www.hollywoodcamerawork.us/trackingplates.html)

[www.digitaltutors.com/11/training.php?cid=203&pid=292](http://www.digitaltutors.com/11/training.php?cid=203&pid=292)

[www.digitaltutors.com/11/training.php?cid=233&pid=454](http://www.digitaltutors.com/11/training.php?cid=233&pid=454)

## 8. SUGGESTED LEARNING ACTIVITIES

- It may sound surprising that the outcome of this module can be just a test render, with some geometry mesh overlayed onto the plate. This reflects industry practice though; it is important to encourage peer review and to develop in students a real critical eye for tracking accuracy. They need to be attentive to geometry that slips or slides over the length of the clip and to understand what tweaks can be tried in order to achieve a better track/solve.
- We aren't suggesting that the 3D matchmoving exercise(s) shouldn't form part of a project that involves modelling, texturing, lighting and compositing as well. Indeed projects like this, already suggested in earlier examples, would give a clear understanding of the entire VFX production process as well as making good showreel clips. What we are keen to avoid here is the passing over of good accurate 3D matchmoving in favour of the more glamorous distractions of CGI production!

- Students should understand the importance of accurate camera/object tracking as it forms the cornerstone of VFX, both in terms of production and in career progression within 3D.
- Although software vendors do provide basic test geometry (usually consisting of drawing pins, cones or company logos), better practice would be to use test geometry built for a plate. This could be fairly basic to begin with. Examples are wireframes of building elevations or street furniture. Once tracked, students could go on to produce finished shots with buildings or street furniture to suit a period, genre or style.

### Total Station Survey

- A total station is a device to measure the distances of objects on set and the total station. It is commonly used in the surveying and construction industries. From the survey a point cloud of the environment is gathered, the data of which can be used to create geometry in a 3D application to position the matchmove camera in. It is like a LIDAR scanner but far cheaper and requires a lot more manual work.
- The cheapest method is to manually measure the on-set environment by tape measure. This obviously is only a solution on-set, and not necessarily in the field. The important thing is that students understand what data needs to be collected, by whatever means they have.
- There is no way of avoiding the acquisition of industry reference standard software, like PFTrack/Boujou/3d Equalizer/Syntheyes. Nuke has a camera tracking operator and can be used to teach tracking to a high enough level.
- In the absence of a client/film director/VFX supervisor, the tutor should highlight and demand high level quality control and accurate work before anything is approved as signed off from this matchmoving module.
- Submission of a proof render that shows the accuracy of camera track (for example there are no slips in geometry in the scene) is an industry standard method of signing off a good matchmove.
- Students could also be required to submit a 3D scene with geometry and camera; for example the Maya file that the render was created from. The assessor can check the scene and the quality of the work (for example whether the shot has been delensed).

*In the industry once a matchmove has been signed off it will be picked up by animators, lighting TDs etc. Any errors then would be apparent and costly.*

# MODULE 007: MATTE PAINTING AND ENVIRONMENTS FOR VFX

## 1. MODULE DESCRIPTION

This module examines the art of matte painting and the role of the environment TD. With the advent of 3D CGI the matte painter's job has increasingly moved away from creating 2D backdrops of landscape and cityscape to include working with geometry in what is often phrased as 2.5D.

In this module the student explores painting techniques and their role in creating environments.

The technological and economic imperative for 2.5D often needs to be accompanied by photoreal paint artistry, informed by an understanding of 3D projection and the awareness of how the virtual camera might be placed.

## 2. SUGGESTED PRE-REQUISITES

- Essential: **001: Acquisition for VFX**
- Essential: Drawing and fine art skills

## 3. SUGGESTED CO-REQUISITES

- Optional: **005: VFX Paint and Rig removal**
- Optional: **006: 3D Matchmoving for VFX**

## 4. AIMS

This module aims to:

- Impart practical techniques broadly defined under the matte painting and environments headings.
- Enable the student to have active engagement with 2D, 2.5D and 3D environments from a photographic, "trompe l'oeil" perspective.
- Support artistically talented students towards paint and environment roles within VFX practice.

## 5. LEARNING OUTCOMES

On completion Students will be able to demonstrate:

- Photographic paint techniques evidenced through both 2D background work and 2.5D artifacts.
- An understanding of the principles and techniques of photogrammetry and painting on geometry.
- A knowledge of matte painting, environment TD and art department roles in a range of contemporary VFX houses.
- A portfolio showing how they have successfully brought their fine art skills into the digital discipline of matte painting.

## 6. OUTLINE CONTENT

Matte painting is an art and not something that can be learnt to completion satisfactorily within a small module

*without exceptional artistic talent to start with. This needs to be borne in mind when situating this module. The success of this module will depend very much on the quality of artist undertaking it.*

A history of matte painting is presented to the student, making them aware of pedigree. It is important that the focus is on matte painting and its glass painting roots in addition to its contextual relationship with traditional painting or fine art.

### Painting technique

Key tuition in painting techniques must have the aim of trompe l'oeil; making a painting look like a photograph, (even if fantastical in terms of theme) and an understanding of the level of detail needed for key pixel resolutions, or the canvas the matte painter will be creating for. As such the student needs to take time deconstructing what visual cues of light, colour and focus make a photograph look real, and mimicking that in their paint and texture techniques.

### Understanding photography

What qualities a lens lends an image and how to mimic that. Matte painting impacts on the quality of the whole digital environment or virtual set, rather than just supplying a theatrical backdrop, but is always fed by an intrinsic visual deconstruction and mimicry of the physical world around the artist and their understanding of the language of film.

The student needs to be introduced to the difference and interrelationship between environment TDs and matte painters, both areas of convergence and departure.

*A useful definition to be aware of, and to communicate to students is that a matte painter often creates images and panoramas with the interplay of light baked in, whilst an environment TD may create textures and geometry designed to be lit and modulated by light and texture later.*

*Because of today's 3D-heavy pipelines the digital environment department is in the ascendancy and matte painting (in its most commonly understood meaning) functions as a smaller yet vital component. This wider perspective needs to be noted in the construction and teaching of this module.*

### Verbal and visual communication

The student needs to work to the director's brief, but when sharing their vision and ideas verbally (and in terms of rough visuals or concepts) it's easy to lead a director to wrong conclusions. The tutor will explore with the student which methods of communication and discourse will minimise this.

Students will create sketchbooks and/or a library of meaningful references.

Battle: Los Angeles  
Courtesy: Sony Pictures UK/Cinesite



# MATTE PAINTING AND ENVIRONMENTS FOR VFX

This module examines the art of matte painting and the role of the environment TD. With the advent of 3D CGI the matte painter's job has increasingly moved away from creating 2D backdrops of landscape and cityscape to include working with geometry in what is often phrased as 2.5D.

# MODULE 007

## Simple direction on colour spaces

How they might be used in matte painting.

## Environment TDs

Students are introduced to their growing role and the rationale behind it and methods for working in 2.5D.

*Environment TDs may use photogrammetry build geometry, and set up a scene that fills the frame. Then ideally a matte painter will take it further by adding a paint component and can sometimes have more interpretative leeway, to create mood for instance, or provide additional details.*

*Much of today's matte painting is achieved on geometry. 2.5D is often an efficient alternative to full 3D.*

## Art and photography based understanding

Understand the concepts of horizon, vanishing point, one point and two point perspective.

Appreciate the relationship between image texture, scale and placement in the scene.

How atmospheric decay works (usually referred to as aerial perspective in traditional painting). Objects in the far distance appear de-saturated with only highlight visible. Low register detail tends to not be visible and contrast is lost.

Understanding the limits of photographic exposure and determining how true the digital painting stays to this phenomenon. References can be found in landscape and/or cityscape photography. For example, if a bright sky or glass covered building is exposed for, other areas will appear underexposed. If dark areas are exposed for, bright sky and highlights will appear over exposed or blown out.

## Software and technique based understanding

A range of 3D-facing technical skills are increasingly needed to enable the use of 3D and communication with 3D departments. Awareness of where cameras will be, and how much they are moving for instance, can aid the matte painter's job.

Students are directed to research Frank Reuter's idea regarding how to set up a matte painting coverage map, which is of great use to matte painters and environment TDs alike:

[www.thefoundry.co.uk/articles/2009/12/01/90/nuke-production-workflows-coverage-maps](http://www.thefoundry.co.uk/articles/2009/12/01/90/nuke-production-workflows-coverage-maps)

An outline of the principles and techniques of photogrammetry, dense point clouds and image based modelling techniques, within software.

Combining Photoshop imagery with projection techniques.

When to texture objects and when it is more appropriate to use projections.

Re-painting onto textures, using UV mapping techniques.

Creating basic geometry.

The need to understand photographic cues, and apply those to creating something that can't be created from photos.

Sourcing and manipulating textures.

Knowing how to deal with grain and noise.

## Bit depth and colour space

*Note: Students will have an introductory knowledge of this, having encountered it in 001: the Acquisition for VFX, which is a pre-requisite to this module.*

An understanding of colour space and the general principles employed when deciding what colour space to use. For example, should you use 8bit, 16bit, or 32bit floating point? Should you paint in Linear, sRGB or LOG colour space and should you save your files as jpeg, tiff, dpx, or openEXR?

## Concept art through to creation of environments

Designing concepts and the difference between concept art and matte paintwork for a shot.

Senior matte painters can often turn to concept design, designing multiple concepts in a day, but the student needs to be made aware how this differs in format, convention and detail to matte painting work.

## Digital painting technique

The student can learn much about painting digital environments from the traditional teaching of landscape painting as a foundation for digital art (in this module some students may choose to put an emphasis on learning to paint digitally from scratch as opposed to the collage of photographs).

*Landscape oil painting, for example, may be taught in stages of:*

- *The sketched layout.*
- *Blocking in areas of basic tonality (imagine an outdoor scene observed through squinted eyes – great tonal ranges appear simplified into several zones).*
- *Consider notions of atmospheric decay and the light source (this is most likely to be direct or diffused sunlight depending on if there is cloud or not).*

The next stage of adding texture and detail will benefit from a mastery of digital tools, although Students will still do well to make and/or collect a range of texture brushes, just like a traditional painter would collect a range of paint brushes. Digital custom texture brushes may be found online or made from motifs within photographs taken (cloud shapes make great custom texture brushes for example).

## In software, the student will need to develop a real intuition for:

- The use of layers, layer masks, opacity and blend modes, (for example, colour dodge, overlay, soft light, hard light, screen, add and multiply) and an understanding of how these can be used to reveal/clone brush in detail from photographic sources.
- Painting with colour; the smudge and history brush as well as soft brushing and erasing back some of your paint work, as necessary.
- Curves, histogram and image editing tools, to finesse areas of colour.
- High level dexterity with pen and graphics tablet, as well as making good use of its pressure sensitivity.

## 7. KEY TEXTS/LITERATURE

Barron, C. Cotta Vaz, M. (2004) *The Invisible Art, The Legends of Movie Matte Painting*, Chronicle Books

Mattingly, D. (2011) *The Digital Matte Painting Handbook*, John Wiley & Sons

3DTotal.com (2009) *Digital Painting Techniques: Practical Techniques of Digital Art Masters: Masters Collection: Volume 1*, Focal Press

Tonge, G (2008) *Bold Visions: A Digital Painting Bible*, David & Charles

Page, N. Robertson, S. Belker, H. Goerner, M. (2006) *Concept Design 2*, Titan Books

Altiner, A. (2005) *Matte Painting (D'artiste)*, Ballistic Publishing

Dusseault, Y. (2008) *Matte Painting 2: Digital Artists Masterclass (D'Artiste)*, Ballistic Publishing

## 8. SUGGESTED LEARNING ACTIVITIES

- *The matte painter has to interpret the director/client's vision, rather than operate in a vacuum.* As such, it is important that the student is constantly briefed and responsive to feedback about their designs throughout the module.

Students should come across challenging situations where verbal and visual communication is attuned and tightened up to avoid misunderstandings or confusion.

It's easy to lead a director to the wrong conclusions. What methods of communication and discourse minimise this?

- Indicative environment TD oriented exercise: Create a virtual set from photographs using photogrammetry, or by visual reference. Choose and take pictures of a street/building/urban viewpoint and then build a believable copy in 2.5D, and set up a legal virtual camera i.e. employing focal length, film back, and depth of field. Then through painting, alter the lighting to suit a different mood/feel. For example transforming sunset to dawn, or summer to winter snow if appropriate. You might choose to take this to an advanced level (a real litmus test of student ability) by adding a camera move through this created environment and including a seemingly invisible transition to a real photograph/scene.

- As an alternative to environments, where you work to fill the frame, take a still from a film sequence and extend or infill part of the existing set, with a small area of matte painting (which will also need work on the embedded alpha channel). Work with a compositor, who will have the job of integrating your painting back into the live action by means of tracking and grading.

*Note: there is an opportunity here to examine how miscommunication between artists or poor workflow management can introduce problems relating to colour space and premultiplication. There is also an opportunity to compare how similar techniques are used to subtly different ends in rig removal and matte painting work.*

- Apply photographic cues to creating something that can't be created from photos- a fantasy image that obeys photographic rules
- Assessment should primarily be a measurement of how believable the work is. The work should demonstrate an acute awareness and understanding of detail, light play, colour and depth.

Students should also highlight what reference they have employed in order to create their work. For example, they should be able to show reference photography which supports their interpretation of the mood and feel of the work. If they have painted a sunset, then this reference should be able to demonstrate and prove that their interpretation is valid.

Finally, part of the assessment should be a group critique. This will give students experience of presenting their work to a client and the ability to take constructive feedback.

# MODULE 008: RIGGING AND CREATURE EFFECTS FOR VFX

## 1. MODULE DESCRIPTION

**This module allows students to explore the role of the rigger and the working relationship and interactions with animators and modellers.**

The rigger essentially occupies a crucial point in the development and enhancement of workflow and pipeline, collaborating with animators to define rig requirements and communicating with and responding to supervisors, character TDs and/or other leads to ensure the rigging is suitable for animation, texturing, lighting and rendering.

Riggers need to design, create, test and maintain character, vehicle, cloth and prop set ups (according to project) and provide a service that responds to animators and works with modellers to create a model that meets technical needs. They collaborate with animators to design appropriate motion controls, often testing extremes of position or pose, ensuring the most efficient and flexible solution is employed.

Rigging work is pivotal in CGI, and therefore has to be carried out on schedule and on budget. Psychologically the rigger needs to handle the challenge of others in their team waiting for their modifications and the danger that a faulty rig could stymie the final animation. Students will need to clearly communicate rigging systems and processes to other team members.

Riggers may need to develop new techniques and processes to solve character production challenges and may even be involved in R&D and tool building to improve and add to the rigging pipeline. As such, the ability to write utility scripts and programs to streamline or automate the rigging set-up process is explored in this module.

## 2. SUGGESTED PRE-REQUISITES

- Optional: **009: Digital Sculpture for VFX**
- Optional: **010: CGI Animation Foundation for VFX**

## 3. SUGGESTED CO-REQUISITES

None

## 4. AIMS

**This module aims to:**

- Provide the in depth knowledge of Maya needed for professional rigging practice.
- Create an environment where the student can explore the role of the rigger and the working relationship and interactions with animators and modellers.
- Give students the skills to design, create, test and maintain characters, vehicle, cloth and prop set ups

(according to project) and provide a service that meets the technical needs for the project at hand.

- Encourage collaboration with animators to design appropriate motion controls.
- Address the student's ability to clearly communicate rigging systems and processes to other team members.

## 5. LEARNING OUTCOMES

**On completion students will be able to demonstrate:**

- A series of varied rigs including characters, vehicle, cloth and prop set-ups that meet professional standards and solve creative issues efficiently.
- They can confidently and successfully collaborate as a team member with animators and modellers, and that their work supports both.
- They can design appropriate motion controls for an animator's needs.
- The ability to clearly communicate rigging systems and processes to others.
- The fundamentals of functional anatomy (joints, bones, skeletons) through an analytical exploration of the inner mechanics of articulated forms.

## 6. OUTLINE CONTENT

This module must supply the in depth knowledge of Maya needed for professional rigging, including a good understanding of 3D forward kinematic/inverse kinematic (FK/IK) skeletal animation systems for both control and deformation of 3D characters (stylised and realistic). The student will be shown that a good rigger needs to break down key structures, yet have an animator's sensibility and a sound overview of modelling techniques.

The module also teaches the fundamentals of functional anatomy - joints, bones and skeletons. This should not be about artistic interpretation but rather an analytical exploration of the inner mechanics of articulated forms.

How types of movement are achieved through joints and subcutaneous systems and how this might also drive secondary animation of cloth, fur, hair or muscle.

Study of physiognomy and facial expression is also encouraged. Studying medical illustrations and photographs can give useful guidance.

Early in the module there will be an introduction to how digital sculpt, creature effects, animation and rigging interact and exchange assets within today's larger facilities. The student gets practical experience of such roles and their interplay.

Clash of the Titans  
Courtesy: Warner Bros/Framestore



# RIGGING AND CREATURE EFFECTS FOR VFX

**This module allows students to explore the role of the rigger and the working relationship and interactions with animators and modellers.**

# MODULE 008

Two types of rig are introduced - animation (puppet) and deformation and how they might be divided into body rigging, facial, non-character (vehicles, mechanics, etc). Students will explore how deformation rigs take data from the animation or puppet rig and deform the final mesh.

Students create a simple rig, adding bones or a skeleton, exploring concepts and tools including skinning, gimbal locks, rotation, joint tool, pivots, mirroring, x-ray function, IK handles, smooth bind, skin clusters, weights, sculpt deformer, jiggle deformer, wire tools (e.g. for mouths), setting up constraints, working with muscles and collisions. Moving from FK to IK.

The student needs to understand rotate orders to prevent gimbal lock and to make sense in terms of how axes are aligned.

An explanation of the use of different languages when creating set ups: C or C++, MEL script, PERL or Python. The use of maths (matrices).

Engineering efficient UI controls needed for the rig and presenting the rig through the UI. Looking at animation friendly controllers and local vs global control. Controls should be visually unique and simple to read from different viewpoints of the model (e.g. heavily zoomed in), ensuring the visual design discourages the error of grabbing the wrong control.

Students will learn that rigging can operate at different levels, or be divided conceptually into different functions. These could be separate roles or the responsibility of one person. The student should have experience of all these areas to varying degrees.

- Maths and engineering - creating tools or nodes,
- TD roles, creating the appropriate UI.
- Riggers as skeleton builders.
- Deformers that operate the skin and muscles, and secondary animation.
- Simulation, such as cloth.

Students need to be proficient in both puppet rigs and deformation rigs and understand their interrelationship. They should be able to justify their rig by how it allows the animator to get the performance they demand.

Students need to understand that different riggers approach problems in different ways, so there may not be a correct rig, only appropriate rigs. It's about creative solutions as much as technical mastery - it may be that you can get the movement you need from simple deformers alone.

Don't over-engineer. It's about keeping your rig efficient and therefore fast. Check what is the fastest way to calculate (a rig is basically just a big calculator). Nodes are faster than expressions in Maya.

Students are made aware that they don't need to do everything in one rig. Make things efficient and logical regarding controls, with an easily operated layout. This may mean sensible parenting and hierarchy, in both IK and FK.

Using FACS, rationale and limitations.

Facial rigs - enabling a greater level of detail

*Riggers should be able to respond to the animator, and that means understanding animation and having animation sensibilities. Also they need to be able to talk topology with the modeller and sometimes they need to make a judgement about when to fix and when to hand back to the modeller. So a good rigger needs to think and communicate like both a modeller and animator.*

*The student needs to practice asking "if I was to animate this, how would I do it?"*

Bringing anatomy observation to bear, students are encouraged to compare real life references to their rig. Look at people walking for instance. This will help students recognise and work with real world limitations that certain configurations of bones/joints will lend their rig.

Students should be supplied with concept drawings/ references for a character and then build and check the rig for dramatic poses, even further than it is envisaged using it, ensuring it has the give to accommodate further scenarios.

*It's important to test the rig with extreme dynamic poses, beyond what might actually be needed. Often animators will want to push poses and if the rig breaks it'll come back to you, so try to second guess. What happens if the mouth is open wider, or the wings are fully unfurled? Exercise the rig to see where its breaking points are.*

Is the rig's hierarchy laid out such that you can revisit and modify later? Were the naming conventions such that it is easy to modify? Have you left enough leeway for the animator to add their flair? Is the rig appropriate for the production?

Throughout the module students get to grips with rapid prototyping: they deliver a rig in stages so they see the value of enabling colleagues to get working, testing and in return giving early feedback on performance. It's about prioritising: control limbs before eyelids! Get the overall skeleton built/scoped and passed to the animator so they can commence work, before moving onto finer details like muscle or jiggle.

Throughout the module students will gain an appreciation that rigging appeals to certain types of people - the technical problem solvers. Rigging can be stressful with everyone waiting for you to feed them.

There's sometimes an assumption that rigging gets easier as you develop a library of reusable rigs but the challenges of rigging never recede - technology and expectation always exceed proficiency.

Students need to be introduced to hair and fur simulation, using key hair as controls, with characteristics of growth such as density, clumping, frequency, curliness, inclination, practicing control of movement via the use of area designation maps, dynamics, constraining and spline animation.

*Hair and fur also needs distinct and complex look development. Here, students should aim for a basic understanding of how materials can be assigned to hair, its opacity and the colour of the underlying skins' contribution to the look of the creature in question and explicit rendering options. Shader development for hair and fur is the stuff of Siggraph papers and as such is considered to be outside the scope of this module.*

The biggest concern in hair and fur simulation for the creature effects animator is how it should bend, stretch and interact with movement caused by primary animation or by the environment the creature finds itself in. As an example of this, students should be directed to think about how fur should squash down on the inside of a bending arm (rather than break through the arms surface), or what should happen to the fur in water or how it might blow in a gale.

## 7. KEY TEXTS/LITERATURE

Ritchie, R., Callery, J., Biri, K. (2007) *The Art of Rigging Volume 1*, CGToolkit

Ritchie, K., Alexander, O., Biri, K. (2006) *The Art of Rigging + DVD: A Definitive Guide to Character Technical Direction with Alias Maya Volume 2*, CG Toolkit

(2007) *The Art of Rigging + DVD: A Definitive Guide to Character Technical Direction with Alias Maya Volume 3*, CG Toolkit

Osipa, J. (2003) *Stop Staring!: Facial Modelling and Animation Done Right*, John Wiley & Sons

Allen, E.,Murdock K.L, Fong J., Sidwell A.G., (2008) *Body Language: Advanced 3D Character Rigging*, John Wiley & Sons;

Jason Schleifer, *Rigging Bundle By Jason Schleifer*, www.jasonschleifer.com

www.hippydrome.com

Ekman, P. Friesen, W. (1978) *Facial Action Coding System (FACS)*, Palo Alto CA: Consulting Psychologists Press

Faigin, G. (1990) *The Artist's Complete Guide to Facial Expression*, Watson-Guptill

Simon, M. (2005) *Facial Expressions: A Visual Reference for Artists*, Watson-Guptill

## 8. SUGGESTED LEARNING ACTIVITIES

- Collaboration: Assuming ready access to skilled student cohorts, the tutor should set up a work schedule where the modeller works on a rough claysculpt, which is then handed to the rigger to engage with. Meanwhile the modeller continues to add lumps, bumps, volume and detail. The rigger simultaneously works with the animator to see what controls and constraints are needed to be modified in the rig. Issues such as pinching and stretching are communicated back to the modeller, who makes corrections.
- A regime of dailies should be instituted, with work signed off by tutors based around this exchange.
- Roadtesting a rig to establish its coherence should be an important exercise.

For instance, move your character by a large factor, say 10000 units in Z. Does it still look the same? Rotate your character in all directions, is it solid, or do things spin out? Does the rig shift if you set all controls to zero? (there are more tests).

If you do a quick export, is the scene the same or have you flushed out much extraneous data?

There should be no redundant controls e.g. two controls doing the same thing, resulting in two f curves describing the same motion.

- Think about holding a (physical) puppetry workshop: building and breathing emotion and motive into pose.
- Team work exercise: students work together on an animation shot, for instance a chase sequence. The rigger works with the modeller to create the CG assailant, based around the characteristics of the rig, which in turn influences creature design. As an example it might be a lumbering giant, or a flapping pterodactyl placed within film footage of a fleeing victim, which has previously been tracked.
- The point is to get students to respond to incremental requests, with the tutor acting as director and asking for changes that have repercussions for everyone on the team and ensuring many iterations before conclusion.

Nanny McPhee and the Big Bang  
Courtesy: Universal Pictures International (UPI)/Framestore



# DIGITAL SCULPTURE FOR VFX

In this module students will extend and advance their skills in modelling. Having learnt the fundamentals of building a hard surface form as well as the basic workflow of CGI production from 002: CGI Foundation (still image) for VFX, here there is further opportunity to learn about creating form and surface for an organic form which needs to be posed, re-posed and animated over time.

## MODULE 009: DIGITAL SCULPTURE FOR VFX

### 1. MODULE DESCRIPTION

In this module students will extend and advance their skills in modelling. Having learnt the fundamentals of building a hard surface form as well as the basic workflow of CGI production from 002: CGI Foundation (still image) for VFX, here there is further opportunity to learn about creating form and surface for an organic form which needs to be posed, re-posed and animated over time.

As well as learning about anatomy and digital sculpture, proper use of topology to eliminate or minimise pinches and stretches during animation is essential. This module instructs on how modelling and animation need to be broken down into distinct stages so work is tested and refined throughout the process of modelling, rigging and animation.

### 2. SUGGESTED PRE-REQUISITES

- Imperative: **002: CGI Foundation (still image) for VFX**

### 3. SUGGESTED CO-REQUISITES

- Imperative: **008: Rigging and Creature Effects for VFX**
- Imperative: **010: CGI Animation Foundation for VFX**

### 4. AIMS

This module aims to:

- Complement and build on the students existing hard surface modelling skills with soft surface modelling aimed at creating organic forms to technical specifications.
- Support and encourage the student's continuing exploration of anatomy and musculature through traditional media in parallel with their CGI work.
- Enable the student to confidently and efficiently clean-up or re-topologise assets.
- Enable the student to develop a proficient level of artistry with sculpture brush tools.
- Give the student experience of dissecting or breaking down models into useful and manageable components as according to industry workflow.

### 5. LEARNING OUTCOMES

On completion students will be able to demonstrate:

- Solid and confident proficiency with relevant software and professional workflow methods.
- Talent in creating complex organic forms to technical specifications.

- A range of analytical studies of organic and natural forms.
- A series of re-topologised assets and versions thereof.
- A proficient level of artistry with sculpture brush tools in their CGI work.

### 6. OUTLINE CONTENT

This module allows the student to explore the role of digital sculpting and soft surface modelling within a typical VFX workflow.

Students will further their understanding of CGI modelling practices. Having previously completed module 010: CGI Animation Foundation for VFX and modelled a hard surface object using a range of techniques whilst keeping the poly count as low as possible, students will now progress to developing skills as digital sculptors (or soft surface modelling) by spending time using software sculpting brushes. Skill with pressure sensitivity and dexterity with a pen and graphics tablet need to be established as second nature when it comes to working in digital sculpture.

Students will be immersed in a culture of sketchbooks of observational and analytical drawing. Anatomy and myology (musculature) reference works are copied and synthesised. Life drawing needs to be available, but should be focused on the particular needs of this module, rather than loose artistic interpretation. Anatomy should be functional – how muscles and joints are evident beneath the form.

As well as aiming to achieve a mastery of digital sculpting tools, there is a premium placed on thinking through how modelling for animation is different from modelling for pure sculpture. This includes understanding the reasons that the mesh created during the sculpture process needs to be cleaned-up or re-topologised and the effect this may have on texturing work that is done later. The student needs to be comfortable in working between different 3D modelling applications (particularly ZBrush and Maya).

In VFX companies digital sculptors will work closely with animators, riggers and creature effects TDs as well as cloth and hair/fur TDs and texture artists.

*Note for tutors: the 'effects' work done by hair/fur or cloth TDs we have explored within 011: Effects Animation for VFX, along with particle and fluid simulation. In the taxonomy by which we are organising modules work done by creature effects TDs relates to things like skin slide or muscle reaction and is driven by primary CGI character animation.*

# MODULE 009

## Develop artistry with sculpture brush tools

Practice and iteration are needed. Sculpting up basic but accurate soft body or organic forms with lots of rounded edges, lumps, bumps and big surface texture is all good practice. You can sculpt from a still life set up in front of you.

Begin with things that can be sculpted up from primitive base meshes. For example, vegetables, fruit, foliage, fast food, shoes, or other objects to hand. Analyse the form for symmetry. Can you draw a line (imagined or real) through the form and see where one side mirrors the other? Symmetry switched on in software can often save time.

## An introduction to character modeling

As the student gains skill and confidence with digital sculpting tools (namely sculpture brushes and a graphics pen and tablet), the student should then start to explore the workflow for sculpting for animation and progress on to character based modelling.

*In a VFX company a concept artist will very often give the digital sculpt artist a visual for the character, that would allow them to draw up image planes, for the figure. Most sculptors will use a front and side profile view to work from. The student will need to think about how they will build a base mesh for the character based on analysis of form, structure, weight and proportion.*

To enable them to do this they will be instructed on how to develop a thorough understanding of the modelling tools in Zbrush and Maya.

## Character modelling and workflow

The student will be shown how to interpret and create appropriate character structures - what are the main forms that need to be sculpted? Which sections consist of different materials such as costume, hair or need surface detail? What parts might be done with hard surface modelling, cloth/hair simulation or via texture mapping?

The student will be taught how to break down the form and how to sculpt/model underlying or part-occluded forms, such as eyes and teeth, as separate models.

Students will learn how to make openings or holes in the form and understand how characters or apparel may need to be sculpted up in sections or groups. Recognising when the use of hard surface modelling techniques may be appropriate for objects such as weaponry or mechanics. Exporting parts of the model to other software as necessary.

Making line drawings for planes through the form, at the least front cross section and profile cross section (working with character designs from the concept artist).

Considering pose, proportion and symmetry for those parts of the job that need digital sculpture work. Constructing base mesh using appropriate tools such as z-spheres.

Editing mesh detail, as appropriate.

Adding main lumps and bumps via sculpture brush artistry.

Reviewing the preliminary work in animation, attending to pinching/stretching type problems and getting sign off for the model at this stage.

Refining and adding further shape and mass via sculpture brush artistry.

Understanding how to clean-up (re-topologise) the model as necessary.

Considering how surface details will be added either by the student or by a texture artist later on.

## 7. KEY TEXTS/LITERATURE

Eric Keller, E. (2011) *Introducing ZBrush 4*, John Wiley & Sons

Spencer, S. (2011) *ZBrush Character Creation: Advanced Digital Sculpting*, John Wiley & Sons

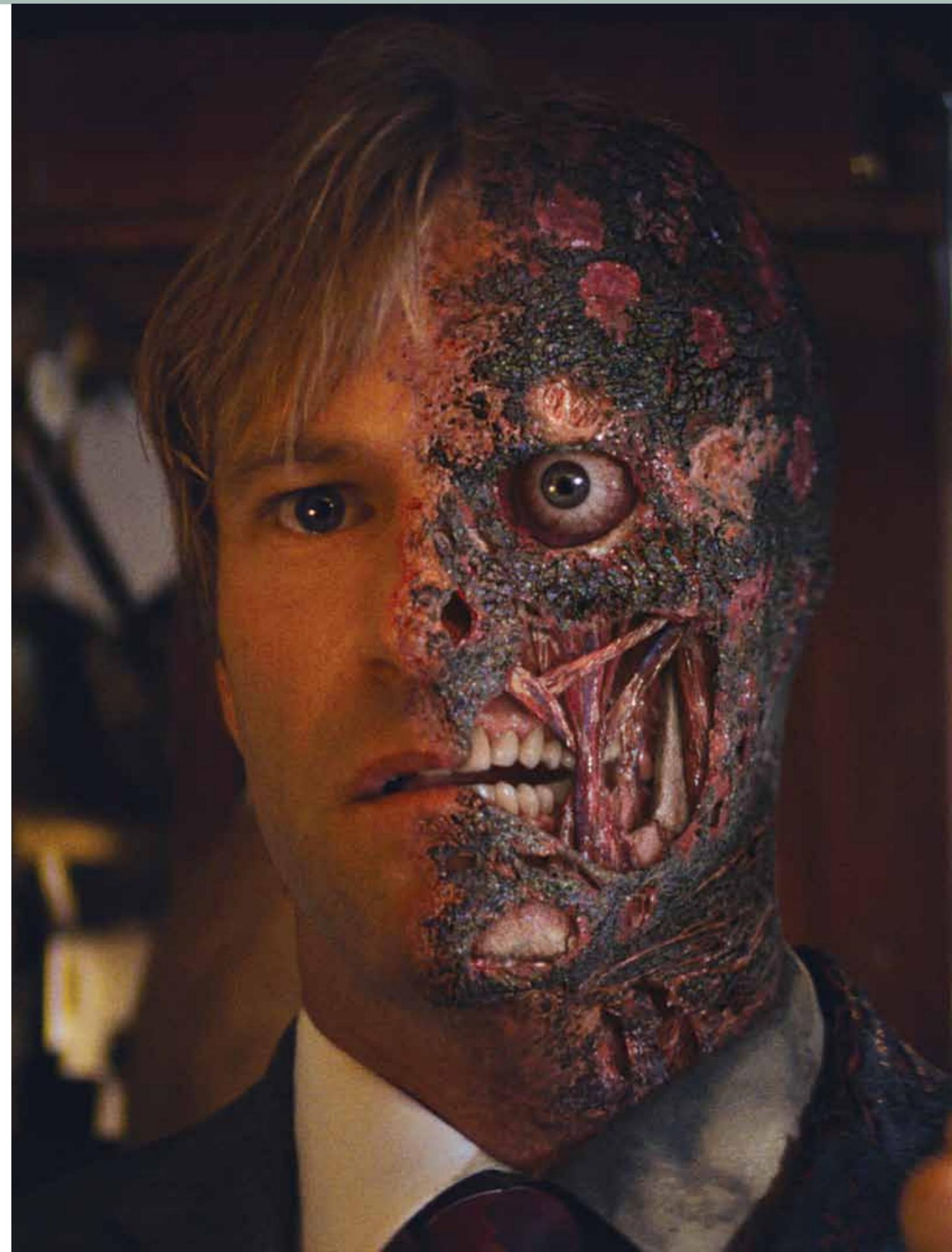
Spencer, S. (2010) *ZBrush Digital Sculpting Human Anatomy*, John Wiley & Sons; DVD edition

Goldfinger, E. (1992) *Human Anatomy for Artists: The Elements of Form*, OUP USA

Simblet, S. (2009) *The Drawing Book: An innovative, practical approach to drawing the world around you*, Dorling Kindersley

Speed, H. (2009) *The Practice and Science of Drawing*, BiblioBazaar

Dubé, R.L. (1996) *Natural Pattern Forms: A Practical Sourcebook*, John Wiley & Sons



The Dark Knight  
Courtesy: Warner Bros / Framestore

# CGI ANIMATION FOUNDATION FOR VFX

This module examines animation as part of a VFX pipeline, rather than as an isolated discipline. Whilst elements of the module may well pertain to Pixar or Aardman style CGI animation, it is examined here as part of a process initiated by, and then complementing, a live action shoot. As such the VFX animator often has different constraints on their work, with matchmove and layout departments setting the scope of their work.



## MODULE 010: CGI ANIMATION FOUNDATION FOR VFX

### 1. MODULE DESCRIPTION

This module examines animation as part of a VFX pipeline, rather than as an isolated discipline. Whilst elements of the module may well pertain to Pixar or Aardman style CGI animation, it is examined here as part of a process initiated by, and then complementing, a live action shoot. As such the VFX animator often has different constraints on their work, with matchmove and layout departments setting the scope of their work.

Layout represents the translation of the original storyboard into the 3D animation world and matchmove provides the positional and temporal rules of engagement for the animator. It's here that the camera is defined and the relative positions of key animated elements or characters are set. The animator's role is then to react and build on these constraints and sometimes to feed back to others. This is often different from the relative free reign that animation students are given in more general CGI animation modules at university, where they can dictate camera position, lighting and extraneous elements for dramatic effect themselves.

With the accent on VFX, this module does not concern itself with wholly character animation and its often exaggerated plasticity. The student will instead animate objects and characters as dictated by background film plates. As animation skills are learnt iteratively, this module stands distinct from modelling and rigging and these assets are supplied to allow more focus on the practice of animation.

It is important that new entrants into the industry appreciate that believable or realistic movement of often unnoticed CGI elements onto a live action plate isn't a less creative activity than wholly character based CGI features, which often seem more flexible in terms of style.

Senior VFX character animators agree that there is still much room for interpretation and individual nuance within VFX animation and that they have often been hired specifically for this individual creativity. Today's student should expect to take a few years to get to this stage though.

### 2. SUGGESTED PRE-REQUISITES

- 001: Acquisition for VFX
- 006: 3D Matchmoving for VFX

### 3. SUGGESTED CO-REQUISITES

- 008: Rigging and Creature Effects for VFX
- 009: Digital Sculpture for VFX

### 4. AIMS

This module aims to:

- Enable students to develop a strong understanding of core animation skills such as weight balance, squash and stretch and follow-through, required for believable VFX animation.
- Provide students with the tools to mimic or replicate form and motion accurately through drawing and animation assets.
- Give students the ability to perform visual and analytical problem solving in three dimensional space, including the ability to accurately interpret 3D layouts and analyse 3D form.
- Explain VFX animation pipelines.
- Encourage students to learn 3D animation software to a high level, informed by strong animation skills.

### 5. LEARNING OUTCOMES

On completion students will be able to demonstrate:

- A portfolio of animation that responds and conforms to interaction between layout and rigging artist prerequisites.
- Believable animation based on observation and mimicry of live moving forms.
- A series of turntables of characters and objects poses.
- Appropriate animation of rough/simple models within a live action background plate.

### 6. OUTLINE CONTENT

#### Fundamentals of animation

Core animation skills are taught on and off the computer screen, notably squash and stretch and weight. For instance, themed as a series: bubbles, water filled balloons, beachballs, footballs, cannonballs.

Follow-through, for instance adding a string or loose tail to a moving object.

Principles and practice of a range of walk cycles starting with bipedal, progressing to quadraped.

Walk cycles, run cycles, footslip.

Translating a walk cycle forward and turning on a path, advancing to walking up stairs and over obstacles.

Emphasising character weight and balance.

#### Fundamentals of 3D CGI Animation

(Taught through Maya or XSI etc)

The module explains the distinction between primary animation and secondary animation or creature FX.

# MODULE 010

How form is articulated through space.

Hierarchical animation.

Clusters, blend shapes and pivot points.

Advanced graph editor.

Inverse Kinematics vs. Forward Kinematics.

Students will note that most animation jobs need "excellent Maya animation skills" and will receive training towards this end, but will be expected to be pro-active in seeking out time and resources themselves.

## Rigs

Students are presented with a rigged creature and taught how to put this through a series of poses and simple animated routines.

Simple movements can show recruiters that students have animation skills. A simple fall or a rig reacting to a force can show students have thought about centre of weight and momentum and can deal with other abstract, essential qualities for animation.

Throughout the module, students will be immersed in a culture of sketchbooks of observational and analytical drawing. Anatomy and myology (musculature) reference works are copied and synthesised. Life drawing is offered, but should be focused on the needs of a VFX animator rather than loose artistic interpretation. Anatomy should be functional – how muscles and joints contribute to movement.

Such drawing should extend beyond the human form; observing animal movement first hand in the zoo or park, or at least on video. Sketching a variety of skeletons in a museum would be an option. Students gain the ability to analyse organic motion and have a good understanding of realistic weight and timing.

Students should learn to value mimicry, based on observation, without stylisation. Even mythic animals or imagined creatures can be referenced via close equivalents in the animal world, observed via video, if not live.

Physical sculpture sessions (for instance clay) may also be encouraged as a means to understand how form betrays its underlying structure.

As an introduction, students will explore the limitations of different animated forms - procedural animation, simulation based systems such as fluids, rigid body dynamics and how they compare in terms of efficiency and function to various tasks. An appreciation of when to animate and when to use simulation is needed.

Students may partake in workshops in acting, exploring different interpretations and nuances of the same action, or a workshop with a professional puppeteer, learning about how to communicate motive and emotion through strong pose.

Drawing can inform the preparation of animation work by allowing the student to uncover the mechanics of movement, but it also increases the animator's ability to communicate non-verbally with layout and rigging departments, as well as bringing later benefits towards communicating to clients and supervisors.

It is helpful for the student to think of animation through the dual perspective of motion (mechanics, physics, timing), and emotion (acting, motivation, pose, expression), and understand they may be called on to replicate the real, or exaggerate and extrapolate it.

Motion fundamentals; seeing animation as time/position.

What are key poses? Dissecting an action. What is going on under skin, or as forces are applied.

The student needs to be aware of the spectrum of realistic movement through to exaggerated character and understand the core of their study in this module is around servicing VFX pipelines, not Pixar-style feature animation.

The process by which an animator fits into a pipeline will be examined, with an introduction to match moving and animation layout and the process by which scenes are blocked and basic positions are signed off explained.

In large VFX houses the matchmove department provides assets to the layout department. Blocking is often where key decisions are made that will effect the animator's work later, setting characters into position. This is then passed on to animation.

The student is exposed to variants of this pipeline. It is important for the animator to understand that camera position and rough action has already been set. In addition, in this module the student will be concentrating on working in this pipeline, not on getting bogged down in modelling, lighting, texture, etc.

There needs to be ample opportunity in the module for riggers and animators to interact, to ensure the delivery of a rig that will meet an animator's need for control, functionality, usability and performance. Rigs will be supplied, enabling the student to test, critique and learn by reverse engineering.

As we are encouraging the student to work with a pipeline mentality, dailies and crits will be embedded in the student cohort's schedule.

Group projects and collaboration will be combined with constant opportunities for peer critique, instilling notions of what goes on before and after the animator has created work.

Students will appreciate how others are impacted by their decisions. It's not about just how it moves, but how it will look later too and elements need to be flexible for this eventuality.

Turntabling/in the round. Characters integrity from all angles must be clearly displayed and students will need to turntable their work.

Students will work on 'previz', possibly for other students, (or as an exercise to re-engineer films already made), displaying and stretching their previous understanding of the filmmaking process and cinematography. There will be an emphasis on shot turnover that achieves a balance between both meeting deadlines and quality expectations.

Lipsync should be explored through a series of exercises from a VFX rather than a CGI feature perspective with its inherently exaggerated characters. One might address how realistic objects might articulate sound and have expression.

## BODY TRACKING

This is the process where geometry is keyframe animated to fit and exactly copy the movement of a photographed element in the plate. Geometric shapes (cars, boats, planes or house bricks), which need to act as 'collision geometry' for effects work are sometimes 'roto-mated', but more often than not they will be procedurally 'object tracked' (see Module 006: 3D Matchmoving for VFX). People or creatures are more difficult. For example, an actors body may need to be 'roto-mated' by overlaying some rigged body geometry onto the plate in 3D software. An animator will keyframe and in effect 'trace' the actors movement using the 3D body model. You'll see why the term 'body tracking' is often used to describe this process.

The technique of body tracking could well act as a good introductory exercise to the fundamentals of 3D CGI animation.

## 7. KEY TEXTS/LITERATURE

Hooks, E. (2000) *Acting for Animators*, Heineman

Williams, R. E. (2009) *The Animator's Survival Kit*, Faber and Faber

White, T. (2006) *Animation from Pencils to Pixels: Classical Techniques for the Digital Animator*, Focal Press

Webster, C. (2005) *Animation: The Mechanics of Motion*, Focal Press

Muybridge, E. (2007) *Muybridge's Human Figure in Motion*, Dover Electronic Clip Art

Simon, M. (2003) *Facial Expressions: A Visual Reference for Artists*, Watson-Guption Publications

Simon, M. (2008) *Facial Expressions: Babies to Teens - A Visual Reference for Artists*, Watson-Guption Publications

Chakkour, M. H. (2004) *Virtual Pose: The Ultimate Visual Reference Series for Drawing the Human Figure*, North Light Books

Beiman, N. (2010) *Animated Performance: Bringing Imaginary Animal, Human and Fantasy Characters to Life*, AVA Publishing

Sharpe, J., Lumsden, C.J., Woolridge, N., (2008) *In Silico: 3D Animation and Simulation of Cell Biology with Maya and MEL*, Morgan Kaufmann

Weishar, P.(2004) *CGI: The Art of the 3D Computer-Generated Image*, ABRAMS

## 8. SUGGESTED LEARNING ACTIVITIES

- Swapping one set of properties for another: mimic something light and nimble, then change it's qualities and animate as if it is heavy, or more sluggish.
- The student is required to make their shot work between given shots that are already animated in situ with live action plates. The character/objects needn't be more than a rough greyscale, since the exercise is centred on movement and the interpretation of cinematographic rules.
- Variants on this exercise should be encouraged. Students all do a matchmove of a different shot from plates supplied. Then exchange these shots so they all complete a layout for another shot, swap shots again and then all complete an individual animation that conforms to the given shot. Students learn about the implications of what they receive and pass on. Learning is strengthened and accelerated by daily critiques along the way. Such an exercise could involve interaction between different year groups, if this is possible.
- Body track an actor, performing some action. Particularly challenging are movements which are on the camera's axis and are therefore shortened.

# MODULE 011: EFFECTS ANIMATION FOR VFX

## 1. MODULE DESCRIPTION

**In this module students will learn about making particle systems, structures, cloth, fluids and crowds move under the forces of physics. These tasks are the job of an effects animator or effects technical director.**

Instead of using keyframes to animate, students will be setting simulation behaviours and judging what works and what doesn't. Complex phenomena are often more convincingly simulated rather than keyframed. Effects animators may get involved in blowing things up, setting fire to objects, adding dust over the top of a dinosaurs foot fall, breaking glass, simulating fluids or a ships sails as they flap in the wind. Students need to be able to understand and communicate using the language of Newtonian mechanics.

They will be expected to analyse in detail the important characteristics of what are largely natural phenomenon before setting out to simulate such by dialling in and trialling changes within the parameters of simulators or solvers.

A thorough understanding of the VFX pipeline, as well as general animation principles, applied maths and VFX element photography is necessary to inform elegant solutions to this kind of effects work, as it can demand a blend of approaches to meet client expectations as well as keeping data sets efficient and manageable. The student will learn how important planning and efficiency are as factors and why pre-visualisation and processor-saving shortcuts are important.

Through learning how to modify solvers and develop scripting skills (e.g. Python), as well as to batch, automate and improve software interoperability, they will get a firm introduction into tool/pipeline research and development for VFX, should the student want to move in that direction.

## 2. SUGGESTED PRE-REQUISITES

- Optional: **010: CGI Animation Foundation for VFX**
- Optional: Physics A level
- Recommended: Maths A level

## 3. SUGGESTED CO-REQUISITES

- Optional: **002: CGI Foundation (still image) for VFX,**
- Optional: **003: Foundation in VFX Compositing**
- Optional: **008: Rigging and Creature Effects for VFX**

## 4. AIMS

**This module aims to:**

- Give students a clear understanding of how to combine scientific, logical thinking and observational skills to create effective simulation and effects solutions.
- Instil a work practice based around goal oriented iteration rather than random experimentation and adherence to efficient workflows.
- Make the student aware of the appropriate use of simulations and effects, taking into account complexity, rendering, time, memory and resource overheads.

## 5. LEARNING OUTCOMES

**On completion students will be able to demonstrate:**

- Practical effects solutions to real problems.
- A combination of different kinds of simulation, applied appropriately.
- A library of reference works and observations and how they have informed and progressed their development.

## 6. OUTLINE CONTENT

The student's starting point is observation. They are encouraged to look at recommended films for good and bad examples of simulation and to start trying to understand how the physics might have been constructed in what they see.

They need to observe how objects collide in the physical world, by means of analysis of available video and through filming their own references.

The module will include exercises which start in observation, go through research of mechanics and then progress to software iteration.

The student needs to realise that simulation is not necessarily about exotic fire effects and monster goo; it is often about mimicking the mundane to complement a story or embellish or enrich the ordinary. Underwater bubbles, kettle steam, a whirlwind of litter on a housing estate or dust falling from rafters might be the sort of challenges that students should be steered towards.

Students should be introduced to a methodology of rapid prototyping and iteration, rather than working on a perfect model of phenomena.

There should be an emphasis on creative problem solving rather than software mastery; interpretation of a brief (what do you need to simulate and what parameters are actually needed?), design, pre-visualisation, presentation

Prince of Persia: The Sands of Time  
Courtesy: Walt Disney Studio Motion Pictures/Framestore



# EFFECTS ANIMATION FOR VFX

**In this module students will learn about making particle systems, structures, cloth, fluids and crowds move under the forces of physics. These tasks are the job of an effects animator or effects technical director.**

# MODULE 011

and revision are key steps. Students will need to manage time spent on set-ups and sim times effectively and pay attention to disk space that is appropriate for the scale of the production. Students should grapple with the question of how to design an effect from the start, but also get used to pitching and presenting it and communicating their thought processes. They should use their developing knowledge of the VFX pipeline to assess the most efficient ways to provide elements required for lighting and rendering or for further compositing directly.

Is cloth simulation appropriate or is hand animation the best solution, for instance? Students also need to be made aware of the tendency to over-engineer.

Students will receive some tuition in applied maths, fluid dynamics terms and an overview of Newtonian mechanics complemented by a good knowledge of noise functions to make sure everyone shares a similar starting point.

Concepts around Newtonian motion, ballistics, the effect of proximity, forces, velocity, thrust, dampening and dissipation are all useful, especially if this knowledge is combined with observation and analysis of the characteristics of real-world smoke, dust, fog, fire, explosions, water and other fluids. Students should be asking what makes them look the way they do and how is behaviour modified?

## SIMULATION

The module outlines and explores five kinds of simulation.

In each of these the student will explore the notion of cause and effect.

They will use deformers or splines to rig geometry and simulation set-ups driven via simple expressions. They will experience the use of passive or active collision geometry driven by expressions or keyframe animation.

They should appreciate the differences in the level of detail applied to collision geometry as opposed to CGI geometry for rendering.

They should examine the appropriate use of effects fields such as turbulence, gravity, Newton, uniform, air, drag.

### a) Particle dynamics

*Sea foam, dust, precipitation, sandstorms, condensation, jet engine trails and various magic effects are examples, but students should explore practical yet not so obvious uses too. Study needs to be goal-oriented, towards supplying a solution, rather than resorting to haphazardly trying different sliders or variables.*

Elements covered should include point emitters, emitting from surfaces, particles reacting to a hard surface container, use of sprites.

Particles are set in motion and acted upon by external forces such as turbulence, gravity, etc. Streaks, points, spheres, blobbies, clouds and using instanced geometry.

Setting associated attributes such as speed, volume, friction, bounce, lifespan, stickiness, seed and goal. Tricks of the trade regarding processing - if the limit of particles is reached, what then?

### b) Physical dynamics

*Collapsing buildings, buckling, wrecking ball collisions, debris, flotsam, autumn leaves are examples, but get students to explore practical yet not so obvious uses too. Study needs to be goal-oriented, towards supplying a solution, rather than resorting to haphazardly trying different sliders or variables.*

Use hard body or soft body geometry (polygon meshes) as a starting point to create structures which break, shatter, collapse, tear, bend or distort in some way over time. Physical characteristics are defined and forces act upon them. Students should concentrate on attempts to mimic real phenomenon, but also explore pushing parameters subtly, to see if reality can be improved! As an example, collect and observe film material of how large objects fall down if the foundations are removed. How do different stress points effect a collapse? Physical dynamics are often used to simulate destruction and so have many advantages over physical effects on set.

The student should also see that level of detail and modelling for simulation needs to be different from modelling for rendering and how different solutions can be combined. For instance a collapsing building can be comprises hard surface for big blocks and particles for smaller falling rubble.

Shattering objects in certain ways will make a huge difference to constraint or glue set-ups and how the solver will behave. Students will need to pay attention to the UVs carried through the shattering process (and UVs created for the new internal faces made) for rendering purposes. This knowledge is invaluable since the sim might look perfect but if it can't be rendered, the work will have to be redone.

### c) Cloth simulation

*A red carpet rolling down stairs, silk versus canvas covering a box or uneven surface, ripping newspapers, a sack race, a bulging plastic bag are examples, but get students to explore practical yet not so obvious uses too. Study needs to be goal-oriented, towards supplying a solution, rather than resorting to haphazardly trying different sliders or variables.*

Cloth simulation uses meshes as a starting point. Subdivision of surfaces, splitting and joining polys as necessary to create a desired effect, need to be explored.

Obtaining good references are important here. Try video clips or even obtaining different materials. Comparison exercises; by changing software attributes and trialling (caching or rendering) students judge how close their

simulation is to the reference, exploring properties such as compression, bending, stretching, shearing, rigidity, thickness, mass, lift, drag, friction.

### d) Fluid simulation

*A calm or rough seascape, how jetties or moored vessels displace water and how it might lap around them, treacle dripping off a spoon at different viscosities, a ships wake are all examples, but fluid simulation is used more for smoke, fire and explosions. Students are guided to explore practical yet not so obvious uses too. Study needs to be goal-oriented, towards supplying a solution, rather than resorting to haphazardly trying different sliders or variables.*

Output mesh, particles, or some kind of volume data. Scripting and editing fluid solvers.

An introduction to look development and compositing is especially pertinent at this point. Students need to be told how any simulation may later be lit and built upon. Waters properties are especially difficult due to reflection, refraction and translucency which are properties of passes created later by look dev (lighting TDs); and this means that requests may then come back down the line after this happens to change the simulation as certain characteristics may then need accentuating or downplaying.

The interaction of different simulation types is also important, using fluids to move particles, emitting spark particles from a fire fluid simulation etc.

Fluid simulation may be a good point to talk through the integration of effect into plate: rendering, motion blur, depth blur, colour effects, grain, transparency and shadow, edge quality and restoring background areas of the plate can all have implications for effects. Building efficient workflows will be important to get quick turnarounds.

### e) Crowd simulation

*Herds of cattle intersecting, a mass panic, swarming, retreating soldiers, shoals of fish fleeing or feeding are examples, but get students to explore practical yet not so obvious uses too. Study needs to be goal-oriented, towards supplying a solution, rather than resorting to haphazardly trying different sliders or variables.*

Procedural creation. Flocking behaviour etc.

Massive software. Looking at how background sims might interact or reflect the behaviour of photographed foreground actors.

An overview of the use of motion capture for crowd animation and photographed elements as sprites on cards.

## RENDERING

The last component of this module is rendering and looking at pipeline and software interoperability: moving from modelling to simulation and from simulation to lighting and rendering.

Students may examine software and hardware rendering and approaches to rendering the final asset.

They should be presented with case studies of how work might pass through from Maya to Houdini to Maya, and how Python might be used to enable flexible pipelines.

Students should be made aware of the issues involved in the integration of elements from different renderers or passes.

### A note on Stereo 3D

Stereo 3D conversion work includes re-projection and/or displacement via depth maps, but effects will not work via this process. In conversion work (popular at the moment) the use of essentially flat cards of particles is exposed as having no volume or depth in stereo 3D and the illusion is negated. Volumetric effects require more thought in stereo, as it can be very hard to post-convert this type of element.

In other words, cheats and processor saving shortcuts like flat representations of particles won't work in Stereo 3D conversion work.

In true CGI Stereo 3D, with its native 3D space, effects systems have no such limitations, but obviously there are processor and resource overheads to consider since you can't cheat with flat baked-in cards.

## 7. KEY TEXTS/LITERATURE

Motion Mountain [www.motionmountain.net](http://www.motionmountain.net) by Dr. Christof Schiller

[www.red3d.com/cwr/boids](http://www.red3d.com/cwr/boids)

Zwerman, Okun (2010) *The VES Handbook of Visual Effects*, Focal Press

## 8. SUGGESTED LEARNING ACTIVITIES

- Building or having access to a library of video clips of relevant natural phenomena would be advantageous, which could support students own efforts.

Tutors could look at whether students from film or video departments might be called on to shoot natural phenomena to a brief with requisite health and safety awareness and risk assessment. Shooting fire, steam, water is not something that should be done lightly.

Students should try and note down for each clip what physical forces are acting on the objects they are studying or filming and explain, based on the material and environmental physics, why the phenomena behave as they do.

- Whilst Maya maybe the main tool of choice at most institutions, consideration might be given to acquisition of other industry reference software such as Real flow, FumeFX, PhysX, and Houdini.

# CGI LIGHTING AND LOOK DEVELOPMENT FOR VFX

This module explores the skills that constitute and surround the role of the lighting TD. Lighting is also a fundamental skill required by generalists who cover more than one role when working on smaller projects.

Battle: Los Angeles  
Courtesy: Sony Pictures UK/Cinesite



## MODULE 012: CGI LIGHTING AND LOOK DEVELOPMENT FOR VFX

### 1. MODULE DESCRIPTION

This module explores the skills that constitute and surround the role of the lighting TD. Lighting is also a fundamental skill required by generalists who cover more than one role when working on smaller projects.

The process of balancing CGI texturing, shader development, lighting and rendering to match a reference image is called look development (look dev) and this module is concerned with providing the mixture of art, science and maths skills needed. Maths and software may power the technical processes, but art and cinematographic observation and awareness uniquely supply the emotional impact and believability of the world portrayed on screen. As such this module attempts to teach and blend the science and art of light.

It is important for the student to understand that look dev should be done as a global exercise pertaining to the model or creature that appears in a number of shots. This look needs to be approved by staff before any animation work begins, yet in reality the look dev will continue to progress from this point onwards. It is very rare on a film project that look dev would be completed before the animation itself is complete. Usually the two will run in parallel.

Lighting TDs add the lighting that creates atmosphere, adding realism, tone and depth to a scene; visually balancing individual elements to enable a compositor to produce a convincing and consistent range of images. They need to use technical skill and aesthetic judgement in order to create images that not only look right but can be rendered efficiently. They ensure the CG looks believable to match the live action plates.

### 2. SUGGESTED PRE-REQUISITES

- Imperative: **001: Acquisition for VFX**
- Optional: **002: CGI Foundation (still image) for VFX**
- Optional: **003: Foundation in VFX Compositing**

### 3. SUGGESTED CO-REQUISITES

- Optional: **008: Rigging and Creature Effects for VFX**

### 4. AIMS

This module aims to:

- Give students a foundation in all aspects of the field of look development, to the level that they can start building informed but simple pipelines.
- Allow students to develop skill and confidence with light in order to create a spread of different set-ups.
- Impress on students the interrelationship of lighting,

shaders, rendering and compositing.

- Teach the main technologies and processes of look dev.
- Give students a blend of maths and art that they can synthesise into good look development work.

### 5. LEARNING OUTCOMES

On completion students will be able to demonstrate:

- They can make sound assessments in the creation of efficient pipelines.
- The co-option of artistic and cinematic aesthetics in their work.
- They have utilised appropriate technological solutions to work creatively towards a brief.
- They can articulate, analyse and reflect upon their work through using both the languages of art/cinema and maths/science.

### 6. OUTLINE CONTENT

#### The language of art and cinema

Lighting TDs, like many roles within VFX, are a mix of art and technology competencies. As such they need to be able to communicate and think in two languages. One of these languages relates to cinema and art - to communicate the look to other artists or even a DoP or director.

This module needs to give students a tour of milestones of art history within the context of lighting and its effect on surfaces, so students develop an artistic lexicon to articulate and communicate lighting scenarios. Studies of masters of light in both art and cinema, like Rembrandt and Vermeer, or John Alton and Gregg Toland need to be contextualised and presented to students.

Being aware of the look of major films and being able to dissect the contributing factors is important, since other films often become references when communicating about the current film you are working on.

#### Exploring real lighting

The module needs to provide a space for exercises and experimentation with real lights. Students should be free to explore the interplay of two or three lights and a camera. It needs to be noted this doesn't need to be a professional studio space, an empty room capable of black-out will allow this. However it is vital health and safety and risk assessment are at the heart of any arrangement. This is a space for students to rapidly engage with different forms of lighting for learning, not production. Students should rapidly be able to explore and try out ideas. Even lighting objects on a tabletop will have benefits.

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Students particularly should explore the difference between diffuse and direct light, how the absence of light can be utilised, different types of lighting (point, area, directional, etc) and conventions used within live action cinematography. By such work they should be able to describe and think of characteristics such as light direction, type, wrap, fall-off or directness, colour, contrast, exposure, absorption, colour bleed/bounce.

The language of the traditional film set lighting department needs to be internalised e.g. "make this more high key".

The tools of the DoP that supply the film director's vision are the lighting kit, so the student should experience a lighting session delivered by a film professional at some point. They should be made aware that people often erroneously try to fix problems by adding complexity and why the tech fix of adding more lights is often the wrong solution.

## Matching light

To assess the students understanding they should be tasked with matching the lighting scheme of a series of photographic and art images with real lights, which are equipped with gels, dimmers and scrim. Some paintings will naturally prove impossible, but from this the student will learn that realistic lighting is only part of the possibilities. They will also see how lights can have an effective or emotive impact.

## Light in CG

Having explored the building blocks of physical lighting the student now needs to see how this translates into CG. In the real world the two main choices are direct or bounce (scattered, diffuse) light.

Firstly the students should try to mimic real world scenarios in CG and discover comparisons and differences, for instance, a CGI area light might be an equivalent to a physical softbox. What is the equivalent to CG parallel light in the real world? An understanding of how CG light (like parallel, area, spotlights and their inherent properties) can mimic but also extend beyond real world lighting should be explored. The student will build up an idea about how CG lighting is based on traditional lighting concepts but sometimes departs from those qualities, for instance the concept of negative light.

What added properties does it allow the CG artist? From these questions emerge investigations into areas of commonality and departure between the two lighting media. Characteristics such as reflections and shadow, radiosity and colour bleed, refraction and fresnel effects should be noted, through experimentation with both real light and CG light, switching on and off in different combinations.

Underpinning this exploration must be the aim to use light to create a film reality and style, simulating to a level to

complete the job, rather than trying to simulate physical reality itself.

Students should be able to look at an image and articulate its lighting components.

Student should receive an introduction in Image based lighting (sphere or fisheye, or Spheron camera) and the ensuing Lat-Long map.

## History of CG light and shaders

Students will be shown Lambert and Phong shading, the models and maths behind them and how these models have been modified and built upon to add to the range of lighting and surface possibilities.

Lighting TDs need to understand the maths behind surface normals and dot product maths. The students should progress to looking at physically derived shading models. Relatively modern developments such as ray tracing and sub-surface scattering (and the range of surfaces that can benefit, such as skin or marble) need to be explained.

It is said that most development from software vendors is currently going into the areas covered by this module. It needs to be made clear to the student that the technology and application of lighting and materials is still developing and they should be proactive in their own research - for instance Siggraph or Eurographics papers.

## A session on optics

Terms and phenomena such as colour, absorption, reflectance, refraction, diffraction, polarization should be covered, as well as atmospheric optics (e.g. Rayleigh scattering), physical based lighting theory, path tracing irradiance caches and photon mapping.

Students should understand that measuring reflectance directly is the scientific way, but its exactness means you cannot account for perceptive quirks of our eyes and brain.

This should be followed and contrasted with Bi-Directional Reflectance Distribution Function (BRDF) to represent surface reflection properties.

## Grading in depth

Students should experience match grading solutions: HSV, curves, exposure (f-stop, t-stop, Cineon code value and printer light points). Offset/add, lift, multiply, blackpoint/whitepoint match grading, clipping, crushing, gamma, contrast and Perlin gain. Primary grading and selective (secondary) grading via ID mattes.

Practical application of film characteristics: understanding of toe and shoulder film exposure curves, log response, Cineon and linear gamma, open exr, application of such to pipeline, lighting and CGI multi-pass rendering/compositing.

## Roles in look development

It could be said that the role of the lighting TD is to mimic digitally what the DoP does practically. The lighting TD needs a thorough understanding of what data or reference images need to be collected from set in order to replicate the DoPs lighting set-up in CG. However, collection of such data should be matched with a good understanding and interpretation of the DoP and director's vision and creative intent.

On some projects, a lighting TD or lighter may be involved in the research and development of different effects for the art director or lighting supervisor. An experienced lighting TD may work with the art department, concept artist or production designer to develop the look of a CGI creature or object, creating a set-up with a hero shot or turntable to get the look dev right, then designing a pipeline based on this shot to ensure the look is correctly applied to different instances of the creature or object in different shots.

*How far the look is reliant on lights or shaders will depend on how the lighting TD will standardise the look, and how flexible it has to be.*

*It is likely that there will be an established design theme for a sequence or a project which the lighting TDs/lighters need to respect. They refer to the relevant production designs and apply that visual style as faithfully as possible, taking care to maintain continuity.*

*In a large company or on a larger project, lighting TDs/lighters are often part of a team, but they need to be able to work with a minimum of supervision, understand the tools available and know how to utilise them to create the desired effects. On smaller productions, the role of lighting TD/lighter may be combined with that of modeller or texture artist.*

Lighting TDs/lighters need to work closely with the rendering and compositing departments to understand and appreciate what is required at the next stage and ensure their material is easy to use and delivered on time.

## Compositing

The role between lighting TD and compositor is increasingly blurred or shifting. The student needs an understanding of the compositor/finishing artist's role and their relation to the lighting TD.

Anything caused by light hitting a lens is the compositor's responsibility, such as halation, bloom, grain, depth of field and in some cases motion blur, although this is usually handled by the TD in the renderer. The lighting TD needs to understand how a compositor uses different passes, in order to supply meaningful plates.

The compositor needs to 'rebuild' a beauty pass or final gather render which is derived from a set of different image based lighting passes, or augment existing CGI/ photography by 'adding' contact, interactive or rim lighting to help it sit in the plate.

Students should create a small pipeline from the renderer to the compositing tool, allowing a compositor to finish the shot based on the renderer's output. The student should be able to make decisions on project workflows: is it better to light and render image passes in 3D or better to allow for re-lighting, with secondary passes in 2D?

Students needs to understand all the passes possible and their effect, as well as secondary utility passes (Arbitrary Output Passes - this is a Renderman term, but very widely used) and colour space, (which is generally linear) and an understanding of LUTs.

## Shaders

Students needs to understand that if the light is correct but the surfaces can't take advantage, you have a problem! The creation of shaders (e.g. for fur, mirrored surfaces, foliage, alien skin) and the difference between hardware and software shading should be expounded. Surface shaders, bump and displacement mapping and procedural shading should be covered.

Students needs to articulate why they might choose different shading models and how the surface properties change the effects of the light.

Information regarding ray tracing vs global illumination models and ray marching (volumetric rendering for smoke, etc) should also be given.

## Rendering

The lighting TD needs to be able to look at a CGI scene with textures, shaders and lights in place and understand how the renderer is going to produce the desired output. Identifying and thinking through the best solution to render problems related particularly to reflection, opacity, self shadowing and radiosity, (which are particularly computationally heavy) should be presented as a major challenge for students. Rather than ray tracing, could the map approach to rendering passes be taken?

*For example, providing a Fresnel pass to allow the compositor to attenuate a raw reflection pass; or rendering material maps to designate areas on the surface of a model that are varnished as distinct from those being tarnished.*

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An appreciation and comparison of different renderers is needed (such as Mental Ray, Maxwell, V-Ray, RenderMan), and the interrelationship of renderer, shader, lighting and multi-pass CGI. The student should see that a large percentage of problems with renderers have implications for the whole pipeline and it is not unusual to have caching and data management or back up issues.

In essence the task of breaking down a scene so it can be rendered efficiently and can be tweaked in compositing rests with the lighting TD.

Notions of rendered image based lighting versus part or full relighting can be explored and the implications of secondary and/or data passes.

Note: At the time of writing, contact or interactive lighting is being added in the composite using 'normal vectors' and 'point position' data passes from 3D. On the horizon is a move away from rendering image based lighting passes out of 3D all together. Instead, shifting 'data' which can be kept live for lighting and shading into final compositing, where it matters. Renderman as a 'system' has moved from cgi into compositing now. Students should be encouraged to think through why this move is so important. Presently there is plenty of discussion on the internet, on this hot topic. Research and creative problem solving could be made an active part of the teaching and learning of full re-lighting for VFX.

## 7. KEY TEXTS/LITERATURE

Glassman, A (1992) *Visions of Light: The Art of Cinematography*, BFI DVD

Brown, B. (2002) *Cinematography: Theory and Practice: Image Making for Cinematographers, Directors, and Videographers*, Focal Press

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Lanier, L. (2008) *Advanced Maya Texturing and Lighting*, John Wiley & Sons

Livny, B.(2007) *Mental Ray for Maya, 3ds Max, and XSI: A 3D Artist's Guide to Rendering*, John Wiley & Sons

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Rudy Cortes, D. R.(2007) *The RenderMan Shading Language Guide*, Delmar

Apodaca, A. A. Gritz, L. (1999) *Advanced RenderMan: Creating CGI for Motion Pictures*, Morgan Kaufmann

Bailey, M. Cunningham, S. (2009) *Graphics Shaders: Theory and Practice*, A K Peters/CRC Press

[www.motionmountain.net/](http://www.motionmountain.net/) by Dr. Christof Schiller

[http://renderwonk.com/publications/s2010shadingcourse/snow/sigg2010\\_physhadcourse\\_ILM\\_slides.compressed.pdf](http://renderwonk.com/publications/s2010shadingcourse/snow/sigg2010_physhadcourse_ILM_slides.compressed.pdf)

## 8. SUGGESTED LEARNING ACTIVITIES

- Although a lighting TD is not an entry level job, some companies do recruit junior lighting TDs, so this module is valuable, as smaller companies look to recruit good all-rounders.
- A high level understanding of VFX lighting, rendering and compositing pipelines will be needed from tutors.
- Rendering CG in the most appropriate way, to allow it to be seamlessly composited into live action plates, is a big part of the job. A good exercise would be to institute teams; designate someone to do the lighting/rendering job and someone to composite. Get them to look at building simple passes and a rendering pipeline between them. The starting point could be a simple set of diffuse, colour, beauty and specular passes, which are then tested in the composite. Students can reflect on this and check what other passes may be needed, for example ID matte passes for grading or vector passes for motion blurring. On more ambitious courses the ultimate challenge would be to see whether, with research, a basic re-lighting pipeline can be made.

# TEACHING NOTES: THE CORE SKILLS OF VFX

## INTRODUCTION

**If there is one overriding issue that is implicitly outlined in this document, it is the challenge of combining VFX skills in context with intensive tuition in increasingly complex software.**

We recognise this is a significant challenge for universities, colleges, tutors and trainers, but we believe the skills outlined in this document offer many novel avenues for pedagogical intervention and interpretation, rather than representing rigid and prescriptive commands. In some ways it is easy to train students in Maya or Nuke, but not so easy to channel young creativity into teamwork, efficiency and the trajectory towards specialism that we outline.

We are aware that most of the voices in this document are from the larger and more populous VFX companies in London rather than the small or sole trader operator, but it's important to realise all the content in this document came from technical and art professionals who were once students themselves and who have a perspective built from personal experience and passion for VFX.

Another important point to bear in mind is that in higher education we have a unique opportunity to support and invigorate the growth of this industry, and we need to recognise that, unless we start to foreground the skills listed here, we will see more work leaching abroad.

We believe that attention to these competencies can increase the quality of our home-grown graduates only with the contribution of inventive teaching methods and innovative and intensive new courses from dedicated tutors.

Within our roundtable industry discussions certain pertinent issues and suggestions arose regarding tuition, which we include here.

## FIRST STEPS AND TEAMS

In the first part of any course it is advisable for students to concentrate on a single topic at a time and so tutors should provide supporting assets or pre-built scene files, etc. If you are teaching modelling, then don't dilute the students time by expecting them to texture, shade and light the model as well. Provide these assets, or if timetables allow, enable them to be fed assets from others studying related topics like texturing or lighting, so they can concentrate solely on the modelling. Likewise, if the subject is animation, provision of a model, rig and render will be needed for them. Once the fundamentals are covered in this way, then team based projects can be increasingly introduced with each student in charge of an aspect of any project.

## SHORTCUTS AND TEMPLATES

Whilst it is important for students to explore software solutions to problems themselves, in some areas, especially within 3D CGI practice, tutors can accelerate learning by demonstrating setting optimum shortcuts and useful templates, explaining routine processes to make things look good (e.g. in rendering and shading) and outlining what dependencies might be caused along the pipeline. Such inside knowledge from tutors can increase the speed of learning substantially.

## CUTTING CLOTH TO SUIT

A vast array of choice can sometimes be deadening for creativity. Ensuring students learn through invention based on a small number of variables and make do in the face of limitation is a useful tactic, rather than emphasising what each menu heading does and the sheer number of options available.

## DAILIES AND PRESENTATION

Get your students to present their work often to their peer group and even others and be questioned by someone in a client/line manager role. Get them to justify their approach and the thinking behind it. You might want to consider videoing this, since it's a great way to feed back. Whilst no-one wants smooth-talking salesmen, you do want concise narratives effectively communicated in the right idiom.

## LIGHTS, CAMERA, ACTION

Students must at sometime be given use of a camera - video or stills. This provides immediate feedback on framing, composition and balance. It speedily gets them used to thinking about lens properties, (why focus is more crucial in telephoto for instance) aspect ratio (why is everything stretched?), focus and a host of issues they will eventually need to mimic in their VFX work.

It will also help training the eye so students can accurately recreate the visual cues that give an object or a scene an aura of verisimilitude.

You can't really understand the camera by theory alone, the student need to experience it. Also, cameras should be accessible for students throughout their VFX study, rather than contained in a single workshop or session.

# TEACHING NOTES: THE CORE SKILLS OF VFX

## DIFFERENT PIPELINES AND ROLES

Universities need to give their students experience of creating and experimenting with a range of different pipelines and production processes if they are to successfully provide students to the larger companies. This is what makes Stuttgart's Filmakademie such a honeypot for talent - it teaches through demarcation of roles as per industry.

## IT'S BROKEN, SO MEND IT

Students need to start problem solving and diagnosing why an image doesn't work. A quick way is to present them with deliberately broken scenes, images or scripts!

Anything that involves detective work and analysis, going back through stages to find why a shot is dysfunctional will speed up learning.

# END NOTE: PERSPIRATION AND INSPIRATION

**Implementing all the VFX modules is a large task. Some universities will choose not to take up the challenge choosing more autodidactic or creative approaches, preferring students to explore notions of VFX from a creative or theoretical base.**

However prospective students may wish to know which courses contain the voice of industry and universities and colleges that start to engage with the contents of this handbook will be doing just that.

From Skillset's point of view, and the VFX industry whose voice we are representing, we will support those that do commit to the journey.

We are currently doing this by a series of funding awards, such as training the trainers of the Skillset Media Academy Network and Skillset Accredited courses, setting up online coaching, masterclasses and visits to European centres of

excellence and heavily discounted software licenses. These awards will be opened up to other universities committing to incorporate the knowledge in these modules.

VFX is evolving and as no single course can cover everything, the tutor's role is to sift and select portions of the skills we outline in this document and deliver them. That needs the proverbial mix of perspiration and inspiration.

For our part we will ensure these modules are updated as industry practice changes and that industry is informed of and assists those courses that work towards producing industry relevant new talent. This is a major undertaking for all of us, but the promise of greater indigenous VFX talent is our aim. Let Skillset know how we can assist you in creating world class courses.

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# THANKS & CONTRIBUTORS

## THANKS

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**Thanks also to Gaynor Davenport and UK Screen.**

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