

CASE STUDY: HOW TO PRODUCE AND DELIVER A 4K SUCCESS

4K

The creative team behind *The Darkest Matter*
talk through their 4K production decisions and experiences



QUESTIONS

around whether or not a project can or should be shot, finished and delivered in 4K abound at nearly every level of media and entertainment. There are some professionals working on multimillion-dollar movies who couldn't be more opposed to the technology, while there are also content creators posting exclusively to YouTube that refuse to work in anything but 4K.

4K

The issue isn't even that simple, as shooting, finishing and delivering can all be handled with separate 4K plans and considerations. For some, the creative opportunities that 4K represents are too enticing to ignore, while others are hesitant to explore the technology due to the extra costs associated with it. So much of the issue comes down to differing opinions about what is a "need" versus what is a "want".

It's easy to get caught up in questions about 4K philosophies, but it's the 4K practicalities that really matter to content creators. There are bottom-line questions that everyone can and should be asking when they're considering 4K, and exploring how some of these specific answers are reached is an invaluable exercise.



DAWRUNNER PRODUCTIONS AND *THE DARKEST MATTER*

Created by the team at Dawnrunner Productions, a full service boutique production house based in San Francisco, *The Darkest Matter* is a sci-fi film that was shot, finished and delivered in 4K. The team's decisions around 4K were felt not only throughout the production, but long after the project wrapped and all of the assets had been archived.

The Dawnrunner Team consists of *The Darkest Matter* director James Fox and cinematographer Geoff Peck, and the two were able to provide some key details about how this project came together and what went into their decisions around 4K at various stages of the project

A blue graphic with the text '4K' in a large, light blue font and a large white number '1' to its right.

BEGIN AT THE BEGINNING

It's easy to lose sight of the fact that a 4K production is still a production like any other. There's an idea that is formed and evolves before any considerations about cameras or shots. That was certainly the case with *The Darkest Matter* and for the movie's director and CEO of Dawnrunner, James Fox.

"The idea for *The Darkest Matter* was really a Dawnrunner Team effort," Fox said. "We had worked with several very talented youth actors and actresses, and we always have an abundance of story ideas. One just took root, and we found ourselves "fantasy casting" with those folks, and then the story began to develop organically. I took a first stab at the script and once the rough draft was complete, it was passed on to Dan Bower who provided the mastery in crafting the depth of the script."

THE STORY

Set in deep space where a colony ship is suddenly destroyed, the story follows a small group of children survivors who find themselves marooned on a mysterious derelict space station. Among them is Elaine Barrett, and as the children begin to turn on each other, the question becomes whether it's better for Elaine to stay on a station filled with angry and violent children or take her chances in the emptiness of space.

ABOUT THE PROJECT

- 1 The project was entirely self-funded by Dawnrunner, and it took them 3 years to raise the capital.
- 2 They knew they'd have to keep cast and crew to an absolute minimum.
- 3 Everyone working on the project would wear multiple hats.
- 4 Also, the project couldn't interfere with their clients or the work that allowed them to make their living even as they opted to do most of the work in-house.

"There were many people who told us we were being too ambitious, that it could not be done, that we were wasting time/money/effort and to scale the project back," stated cinematographer Geoff Peck, who also serves as CTO at Dawnrunner. "But the decision to make this a reality was a company-wide one. We were going to do whatever it took to make the story we wanted to tell a reality."

Keeping an eye on how ambitious they could be in terms of 4K and beyond was a factor for the Dawnrunner Team, even if it wasn't something they consciously considered at the beginning. The creators were focused on how they were going to fund their project with an eye toward how they were going to spend it.

2

PROJECT LOGISTICS

The Dawnrunner Team are big fans of 4K and always have been. Fox is on record as saying that the advantages of filming in 4K are almost like cheating. He's talked through how he can utilize a lot of tricks and cheats while in production without sacrificing quality in post-production. From digital re-framing, to pan and scan, to padding the frame, he feels he has additional layers of control to get the shot that he wants with 4K.



Even with that being the case, the Dawnrunner Team still had to seriously consider whether or not shooting in 4K made sense. Could they afford it? Could they handle 4K in post? Would it be worth it? How much more complicated would the entire process be in 4K?

Could they afford it?

Could they handle 4K in post?

Would it be worth it?

How much more complicated would the entire process be in 4K?

“When we set out to shoot *The Darkest Matter* there was not a ‘standard’ workflow - not that there really is today either, but we’re closer,” the Dawnrunner Team explained. “Everything we researched was a bit too cumbersome for the nimble and fast workflow we required. We took about 3 months to do some test filming, and testing a pipeline. There were a lot of failures in those months, but we eventually started to trail blaze some aspects of it that worked for us.”

RED Sensor Active Pixels: 4520x2540
4K



The Darkest Matter was shot in the RED One's 4.5K mode, which is 4480x1920. A lot of the time we just call that 4K instead of 4.5K for simplicity's sake and it's only a resolution that the RED uses. We're finishing the film at 4K, specifically 4096x1750 (2.35 ratio), so that we can crop and stabilize. In general I tend to lump similar "classes" of resolutions together, so 4K could be 4096x2160 (16:9 "official"), 4096x1750 (2.35 ratio). Same thing with 2K can refer to 2048x1556 (4x3 or anamorphic), 2048x1152 (16:9).

BUDGET CONSIDERATIONS

Everyone on their team wanted to work in 4K, but most initially kept quiet about it because they all assumed it would be out of their budget. As discussions intensified though, the Dawnrunner Team came to realize that it was going to be an effects-heavy film and that they would be filming most of it on a green screen.

4K's impact on their budget was a factor here, but it was a factor in a different way than they envisioned. The team had a lot of prior experience with green screen and knew this environment would create a lot of extra work if not shot correctly. Shooting in 4K would help them ensure they'd get what they needed during production, but they also needed the right camera and format.

"Part of the problem is the capture format, especially compression," said the Team. "That led to discussions about different camera systems that were available at the time and everyone voiced their desire for 4K. After researching the RED One we were sold on the prospect of shooting 4K RAW and made moving to 4K a priority. RED's R3D format hit a lot of the points we were looking for, and we ultimately decided to go with the RED One."

Even for people who have seen and believe in the differences that 4K represents, utilizing 4K was still a conscious decision that had to make sense for their project. It was a decision they knew would affect everything from the camera they chose, to the capture format they used, to the workflow they created. And that's in addition to the direct and indirect impact it meant for their budget.



Part of the problem is the capture format, especially compression. That led to discussions about different camera systems that were available at the time and everyone voiced their desire for 4K.





3

4K REALITIES

Every project is different and even experienced production professionals need to figure out how the logistics of a given project are going to work. Geoff Peck was programming late into the night, researching script actions in various editing platforms and 3D suites. Testing out their workflow and choosing the right format were critical elements of this process.

“With RED’s R3D format, there are no weird quirks for our visual effects artists to deal with, so a pixel is a pixel and a frame is a frame; it’s like film but without having to deal with the processing and scanning,” the Dawnrunner Team said. “We have the advantages of shooting RAW while also saving some space since it’s slightly compressed. There’s support for the format in most applications we use, and it continues to evolve while maintaining backwards-compatibility.”

Though it may be practical, and can make sense creatively, the decision to use 4K still needs to be squared with what makes sense for the budget. The additional investment required for 4K productions is what many professionals point to as the reason they ultimately can’t, or won’t, embrace the technology. Shooting in 4K might require a more expensive camera, but if that camera helps eliminate re-shoots, then isn’t spending a little more now worth avoiding additional expenses?

By capturing that much more information in each shot, the odds that you’re going to be able to get something you can use significantly increases. That’s not to say it’s foolproof, and you’ll never have to re-shoot, but the additional data that 4K generates can be invaluable.

4

SHOOTING IN 4K

The Dawnrunner Team shot *The Darkest Matter* with the RED One camera in 4.5K, and while camera decisions are among the most important for any project, it's really just a piece of the puzzle.

The project also utilized some pretty unique in-house developed hardware such as the iPhone based wireless focus unit for the RED One, a Motion Controlled Dolly for repeatable moves and a custom built green-screen. But those sorts of details are just the beginning.

"*The Darkest Matter* was a film shot entirely on a green screen set which, at the end of each day's shooting, became a bit of a 'bunk room' for the crew," said the Dawnrunner Team. "We slept there, ate there, and essentially did not leave for the entire shooting schedule. It was beyond ambitious."



Had the film been shot in 2K, especially with lower bit-rate codecs, we would have needed to take a lot more time to ensure that our image was perfect and other aspects of the production would have fallen behind.



4K can impact details down to particular shot choices. When a director knows they might not be using everything that's in their particular shot, it can change their approach in many different ways. For the Dawnrunner Team, shooting in the small studio created a number of space issues, but the fact that it was being done in 4K helped alleviate many of them. It allowed them to go back to the shot list and discuss what could be possible.

The differences a 4K production represents aren't just reflected in the budget and particular shots though. 4K can be leveraged in a way that speeds up the entire production process.

"We had a very aggressive schedule to complete principal photography, shooting an average of five pages per day, during which we had to spend extensive time ensuring that we were getting things right from a visual effects perspective as well as keeping an eye on all the production aspects," the Dawnrunner Team explained. "Had the film been shot in 2K, especially with lower bit-rate codecs, we would have needed to take a lot more time to ensure that our image was perfect and other aspects of the production would have fallen behind."

If someone were so inclined, they could easily calculate the additional costs a 4K production represents. However, it's essential to remember that those costs can eventually affect the budget in a positive way.

5

A 4K WORKFLOW

"Before adopting 4K, we used an online edit process; working directly with the camera files in our edit," said the Dawnrunner Team. "That wasn't a realistic option for us with our hardware and we had to develop an offline, proxy workflow. A little bit of effort solved the need for an upgraded editing workstation. Some limitations can't be bypassed, such as the need for extra storage. There are, usually, a range of options to deal with those limitations and it's a matter of finding one that fits your needs."

Throughout media & entertainment, traditionally separate entities like production and post-production are merging, and these sorts of workflow choices reflect this change. Many filmmakers are concerned about the extra data that a 4K production represents, but production for *The Darkest Matter* is proof that it's possible to set up your workflow so that storage and/or bottleneck issues are limited or even completely non-existent.

"Since we shot in a studio for *The Darkest Matter*, we were able to build up an edit workstation on site, and that computer was used for ingestion and media management," the Team explained. "We liked the agility that we gained from having post-production co-located with the shoot so much that we recently designed a custom DIT cart that houses a core-i7 based computer with an Nvidia Quadro K5000 and a 4TB RAID 0/1 array. This cart is rugged enough to go on location with us or live on set."

MANAGING THE EXTRA DATA

It's undeniable that the amount of data with 4K will always be more than a 2K or HD production, but when managed correctly the speed of a workflow can actually increase. Some professionals scoff at this notion, but it comes down to the process that

has or hasn't been established, and it's one that the Dawnrunner Team developed and refined to great success.

"We dump mags directly to the RAID array and also make a back-up copy to an external drive, which can be handed off to a client at the end of the shoot for convenience," the Dawnrunner Team explained. "Having the system on the shoot with us allows us to check our footage, do a first-light color correction, create proxies, even start an assembly edit. Dailies for us are really more like hourlies. We've been able to walk away from some jobs with a nearly complete rough cut, so we don't feel like working in 4K is slowing us down at all."

These sorts of processes are defined and refined throughout various projects, but the details around how it can work are critical. For *The Darkest Matter*, the Dawnrunner Team typically transcoded their proxies into h264 to keep file sizes manageable, although they also used some other formats like Pro-Res and Avid's DNxHD when they knew their artists needed to do some color-grading with the proxies. They window-burned those proxies with timecode and the filename of the master file just in case they ever needed to manually relink their footage. They typically transcoded their proxies at half or quarter the original resolution so that when reconnecting the master files a simple 25% or 50% scale got them to the right resolution, but there are many details in this



“

We've been able to walk away from some jobs with a nearly complete rough cut, so we don't feel like working in 4K is slowing us down at all.

”

area that have changed and evolved from a 2K or HD production.

“The color grading aspect of our workflow is the one that has changed the most since switching to 4K,” the Dawnrunner Team said. “When possible we do a first-light pass of the footage as soon as it's ingested, which often happens during the shoot, and that first-light is baked into the proxies. If we know that the project is going to have a more extreme grade or the coloring is important to narrative and necessary for the editor to see, we'll use ProRes or DNxHD instead of h264 for the proxies so that we can do some grading with them... but this is not used for export. The grading done during the edit process is copied over to the source files and tweaked for a final look. We always export the final delivery with the master source files to ensure the cleanest output.”

That said, *The Darkest Matter* is a notable exception to this. The Dawnrunner Team used uncompressed DPX image sequences as an intermediate format during the visual effects process, but the idea is the same: no compressed formats used in the final delivery.

6

A 4K POST PRODUCTION PROCESS

Regardless of how much production and post are combined on-set, a 4K project is still going to need traditional post-production. For *The Darkest Matter*, the Dawnrunner Team was able to rely on the infrastructure they built at their studio, but still needed to bring in additional power. They had small render farm consisting of 8 headless nodes, and two Mac Pro editing systems that did all the heavy lifting in terms of artist-based work. They also needed to cannibalize a render node and build it up into a workable PC whenever they needed additional artist support.

Post is obviously a critical aspect of any production, but you can really feel and see the differences that a 4K production represents here. Decisions made earlier in the workflow influence these later stages, and that was absolutely the case with *The Darkest Matter*.

INTEGRATION OF TECHNOLOGIES

“We primarily use the Adobe Creative Suite because of its native support for RED footage, integration between editing and effects,” the Team explained. “Another selling point for us is that there is a standard scripting interface across the entire product line that we’ve used to automate a lot of processes that usually involve repetitive manual labor. We can seamlessly switch back and forth between proxies and master files because of the scripts that we use.”

The team developed an arsenal of custom scripts and lightweight applications that worked seamlessly with their picture-editing platform, which started as Final Cut Pro, but the project migrated to Adobe Premiere. They also developed those custom scripts for their 3D modeling and rendering system (3D Studio Max), and a host of small additional free apps, plugins, resources, etc.

POST PLANNING IS ESSENTIAL

Post is also the stage where the extra data that 4K represents comes into play in a major way. The workflow can be managed in an intelligent manner during production, but with that much more data to import, work with and archive, post-production can quickly become complicated. However, even these apparent weaknesses can also be turned into strengths.

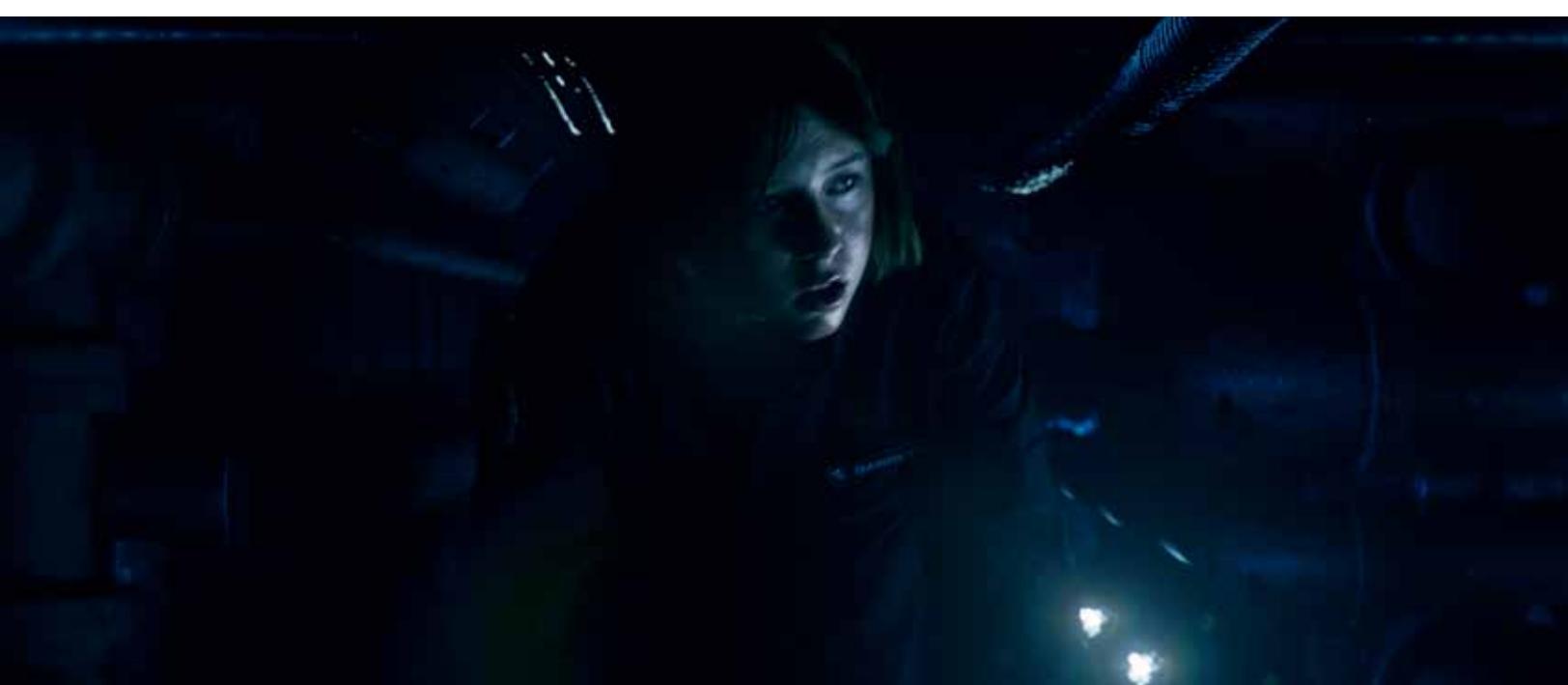
“If the project hadn’t been shot in 4K, we would not have been able to achieve some of the grading and visual effects processes that we ended up using on the film,” the Dawnrunner Team mentioned. “Our 4K workflow involves a first-light color grade to adjust the raw footage as well as an extensive final grade. Lower formats don’t have the latitude to be pushed as far as 4K footage in post and would have been challenging to work with while compositing. We also would have likely needed to extensively process the HD footage to compensate for noise and compression artifacts that would have been present in the raw footage, and that would have been costly and potentially taken longer than working with a cleaner image format from the start.”

While processing and storage needs would have been less if *The Darkest Matter* hadn’t been shot in 4K, the Dawnrunner Team would have needed a much larger post-production team to handle the

additional clean up and manual processes involved when using HD footage for visual effects. 4K footage gave them much better material to start, which saved a lot of time by making their artists' jobs easier. But the differences actually go much deeper.

"Working with 4K in post can be painful if you haven't planned for it," the Dawnrunner Team said. "During our initial testing phase we ran into all kinds of issues from waiting for footage to transfer and running out of magazines, to the footage not im-

porting in the right colorspace or gamma because we didn't do a first-light, to finding out some of our plugins couldn't handle the additional resolution without crashing. We worked through all of these issues and eventually found a workflow that worked for the project. Knowing our post workflow before we shot was vitally important because some of the fixes involved changing the way we shoot or what settings we used on set. Putting the effort into solving the issues ahead of time really paid off. "



7

4K DELIVERY TODAY AND TOMORROW

For *The Darkest Manner*, the Team originally planned to deliver in 2K, but given how quickly the adoption rate of 4K had taken hold they ultimately decided on 4K delivery. It's a distinction that was felt immediately, as the crew noticed a huge difference with the movie being in 4K at the closed screening that family, friends and the Bay Area Press attended.

Working in 4K gives you that option, but just because you shoot in 4K doesn't mean you need to deliver in 4K. The impact of 4K goes beyond considerations in the present though, as delivery resolutions are quickly becoming a top priority for distributors and even for consumers. This means a 4K project can represent something unique and desirable.

"Distribution companies, especially VOD companies like Netflix, will always try to stay ahead of the curve if they can - and they can see 4K on the consumer-horizon," the Dawnrunner Team explained. "We do think there will be a small window of time where there is a heavy preference given to original 4K content. However, that window of opportunity will rapidly close as the rush of 4K content comes on its heels. Following that will be theatrical releases and the general market will widely accept 4K as standard."

DELIVERY FOCUS TOWARD THE FUTURE

However, delivery resolution for today isn't what the Dawnrunner Team was focused on with *The Darkest Matter* or even for the projects they produce for their clients. Their focus truly sets them apart, as many in the industry will only shoot and/or deliver in 4K when they can pass their additional upfront costs to the

client. However, the Dawnrunner Team will take on those extra costs themselves if a client is unwilling to pay for them, which makes them as unique as they are resolved.

Keeping their footage viable for clients and/or for future edits is their true priority, which is why they always push to shoot in 4K, regardless of their delivery. Even if it means more upfront costs, they've seen the ROI for their own projects and for their clients. It's a position that's especially bold, but goes back to their belief in the long-term advantages of 4K, which have already been realized on *The Darkest Matter*.

"We are now being able to go back to the camera RAW footage for *The Darkest Manner*, and upgrade the colorspace and re-edit, re-composite and re-do some of the effects we were unhappy with in the first pass," said the Team. "This is only possible because of the camera we decided to film with. If we had shot with anything else that would not be an option. So for us, this investment has paid off many times over and continues to keep our footage from becoming obsolete or having to go through a costly up-res process."



8

ARCHIVING AND STORING A 4K PROJECT

RED's raw R3D format is incredibly efficient and was a deciding factor for the Dawnrunner Team when they chose their camera, and that decision impacted the projects' archiving. They made a conscious effort to avoid other systems that shoot uncompressed RAW formats, which can use up a lot of space and require ten times as much storage.

EVOLVING & CHANGING

"We archive all of the footage that we shoot," the Dawnrunner Team mentioned. "For *The Darkest Matter*, we have about 2TB of footage, which for a feature is probably pretty small. However, that's just what we shot, as all of the additional visual effects assets and intermediate files bring the project up to about 4TB. For a small production company that can be a lot to handle, but it's not unreasonable."

Data integrity is one of the top priorities for the Dawnrunner Team. They keep two copies of their footage, minimum, as soon as possible after the shoot. But their commitment to data integrity goes far deeper.

"Our long-term storage involves two identical network data servers with 20TB RAID-5 arrays," explained the Dawnrunner Team. "We have one at our headquarters, and dump our footage onto it after the shoot so that it's available to work on. The other

server is located off-site and continually syncs over the Internet. RAID-5 is good for data integrity but isn't always fast enough to work with so the servers also have smaller very high-speed RAID-0 arrays that we use to hold incoming footage and as a workspace to host active projects. This system works well as an archive and should protect against everything from hard-drive failures, theft, fire, etc."

Their system has evolved and changed with the times though. Like so many others, they used to have stacks and stacks of external drives, which was incredibly inconvenient. Moving away from these sorts of inefficiencies takes a conscious effort, and it was one they undertook because of 4K projects like *The Darkest Matter*. The team knew they needed to organize and distribute footage off of these drives, and thus ended up utilizing the RAID servers.

This is another example of how a 4K production's influence is felt in a positive manner. Because of the inherent complexities, a 4K production can actually force creators to refine and redefine an archive process as inefficient as working off hard drives, which in turn increases efficiency across the board.

9

IS 4K A "WANT" OR A "NEED"?

Many have positioned working in 4K in terms of "want" and "need". A producer may "want" 4K for their production, but they don't "need" it. For the Dawnrunner Team, making sure *The Darkest Matter* will be relevant for many years to come is their priority, and that decidedly pushes it from being a "want" into being a "need".

“

We noticed a significant increase in storage costs, but those increases ultimately were far less than the savings we saw in payroll. It's a matter of looking at the big picture and not just focusing on what 4K impacts immediately.

”

“Filming in lower resolutions puts a ticking time bomb on your entire project, the second you roll the camera,” said James Fox. “I’ve often tried to rationalize not shooting in 4K and I find it incredibly difficult. Working in 4K would have to be factored on a project-by-project basis, but people tend to be more scared of the post-production side of costs. For *The Darkest Matter*, we noticed a significant increase in storage costs, but those increases ultimately were far less than the savings we saw in payroll. It’s a matter of looking at the big picture and not just focusing on what 4K impacts immediately.”

During *The Darkest Matter*, the Dawnrunner Team saw these time savings everywhere, from giving their artists more information to work with, to saving those artists time in keying, tracking, and compositing. When the Dawnrunner Team crunched their numbers around an initial projection cost in 2K, they found that projection was about the same as it ended up being when they closed the books after doing everything in 4K.

Of course, the additional costs from 4K are what they are, and even the Dawnrunner Team will tell you such increases comes with the territory. But they’ve also seen and experienced how the right choices and approaches can alleviate those costs in the short and long term. Financial ramifications often force people to qualify 4K as a “want”, but if those budgetary concerns are mitigated, then what’s stopping you from making 4K a “need”?

10

DOES A 4K PRODUCTION MAKE SENSE FOR YOU?

Ultimately, choosing to utilize 4K is a question content creators need to ask and answer themselves, and this takes us away from 4K practicalities and back to 4K philosophy. The advantages that 4K represents have changed how content creators can approach their craft, but if they aren't open to those changes, justifying the logistics will never win them over.

Filmmakers and content creators have always had to work within the limits of whatever format they were shooting. Many professionals were trained on film where the workflow was well established, but expensive and cumbersome. When things progressed to being shot on SD video, the issue was interlacing or pull-down removal. Then the industry moved to HD, and a lot of those formats have non-square pixels, or strange container formats. No matter the format, filmmakers and content creators were forced to deal with inherent limitations. 4K is the first format to remove practically all of these limitations...but it can only do so for those plan accordingly.

"We highly recommend testing a 4K workflow before you commit," said the Dawnrunner Team. "If you find the same benefits in time-savings that we did, you should have no problem justifying the budget increase for a 4K workflow on all projects moving forward, but you need to make sure you have the time to invest in developing this new workflow. Budgets can swing either way, but make sure you're taking into account the entire picture before you make a decision. Longevity of your finished product is becoming more and more of an issue with how rapidly new technologies are being adopted. You may be delivering in 1080p now, but will that be true a year, maybe two from now?"



The Darkest Matter is a 4K success because of how the Dawnrunner Team was able to use 4K effectively and efficiently at every stage of their production. Much of whether or not 4K makes sense for a particular production depends on the project's budget and the window of time that producers have available to get everything done, but the quality of the working resolution should also be greatly considered. That quality will ripple throughout all the visuals of the production today and whenever that project is revisited, meaning these decisions impact far more than the bottom line.

The Dawnrunner Team is currently wrapping up some final polishing of the VFX within the film. Their new theatrical trailer will be releasing very soon which showcases a lot of the new VFX work. They are in the process of fielding a number of distribution offers, and are thrilled to be counted amongst very few films/shows that have been shot, finished and delivered in 4K.